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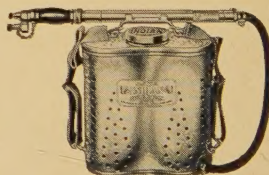
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A professional journal devoted to all branches of forestry

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## EDITORIAL

### WHAT WILL THE HARVEST BE

**D**URING the past four or five years more foresters have been absorbed by the Forest Service and other conservation agencies than at any other equal time in the history of conservation in America. In this group of young foresters are the potential and probable conservation leaders of ten or fifteen years hence. In their hands will rest not only the destiny of forestry in America but also the destiny of the Society of American Foresters. The Society, therefore, has a real and vital interest in the welfare and professional development of this group.

This group of young men have yet to experience so-called, but largely theoretical, "normal times." The chaotic state of the world, widespread experimentation in American government, governmental philosophies contending for world supremacy, the wreckage of the World War, and widespread unemployment are as natural phenomena to them as the airplane and radio. How these abnormal conditions and influences will affect the professional attitudes and outlook of the young men who experienced them is beyond conjecture.

It also appears clear that this group of young men began their professional careers under singularly peculiar conditions.

The emergency conservation work required large numbers of trained foresters. Many young men still in school at the time the demand arose availed themselves of existing educational shortcuts to rush the completion of their college work. Practically everyone, competent and incompetent, got a job. Placement was largely haphazard. Some advanced rapidly, others slowly, still others are now engaged in precisely the same work in which they began.

Never did any group of forest school graduates have better or more varied vocational opportunities than those enjoyed by the graduates of 1932-36 inclusive. It sincerely is to be hoped that a large number of these young men will take full advantage of these opportunities. There are indications that this is not being done. In this connection the older members of the Society may render an inestimable service to the younger generation. Sound advice and guidance are often sorely needed.

One of the most disconcerting facts that may be observed in every section of the country is the considerable number of young foresters who have gone completely "to pot" since graduating from college. Many of these men no doubt are creditably filling their everyday routine duties.

Nevertheless, there appears to be little or no incentive to develop professionally or intellectually. The sports page and the "funnies" are read with avidity but professional papers and more serious books are shunned completely. Were all these men of low intellectual ability, which does not appear to be the case, the problem would not be so serious. All too many men of real ability appear to have fallen in a rut. These men can and should be saved from themselves. Here the profession has a distinct opportunity and a deep responsibility.

It is not an easy task to fire the imagination of young men busily engaged in routine tasks. Nevertheless, it must be done. Not even as virile a profession as forestry can carry the load of a large number of men professionally dead without seriously affecting the spiritual and intellectual tone of the entire group. Ways must be found to arouse and stimulate these men professionally. In many cases a helping hand may be effective. In other cases more drastic methods must be employed.

In this program of professional rehabilitation the Society may play an important role. First of all, these men should be members of the Society. But this in itself is not enough. They must participate actively in its affairs. This does not mean that every member of the Society can attend its annual or summer meetings. Desirable though this may be, it is not an absolute necessity. The Section meetings of the Society may be attended without great sacrifice in many instances. The pages of the JOURNAL are open to the younger as well as the older members. The younger age class should be heard from more often. A professional attitude, though hard to define and somewhat intangible, is a real and vital thing. It can be developed only slowly but it must be developed in every man

who would participate in a professional activity.

The forest schools and colleges also may play a part in this program. Perhaps closer contacts could be developed between the schools and their younger graduates. The young graduate should be inspired constantly to grow in professional and intellectual stature. In some cases men of outstanding ability should be encouraged to undertake graduate work. A few might be encouraged to spend a few months or more in foreign travel. Some might be encouraged to spend several months in visiting the important forest regions of the United States. All should be encouraged to build up a small professional library and to use it constantly. This, indeed, is a minimum requirement. A forester without a working library cannot long remain a forester.

The agencies employing foresters have the greatest and most direct responsibility. These might well insist on a program of continuous professional development and growth. New duties and responsibilities should be given to those whose past performances justify them. Discussion groups might be arranged. Perhaps at some future time a definite course of continuous study may be devised for all junior forest officers.

These proposals cannot be put into operation over night. Both time and money are necessary. Although little can be done to help young men who lack ability, energy, or ambition, there still remains a much larger group with higher than average personal and intellectual qualifications who have fallen to the level of their environment. These men must not be permitted to lose sight of their professional objectives or to surrender their professional ideals. They must be made to travel the path of professional and intellectual growth. Among this group may be the future forestry leaders of tomorrow. These men can and must be saved

# THE HISTORY OF SHIPMAST LOCUST

By S. B. DETWILER

*Section of Hillculture Studies, Soil Conservation Service*

Shipmast locust (*Robinia pseudoacacia* var. *rectissima*) is a much better tree than the ordinary black locust (*Robinia pseudoacacia* L.) in erosion control operations. Although this variety of black locust has been known to be on Long Island for a great number of years, it was given little systematic attention until about 1920. In the following article, S. B. Detwiler gives the historical background of the shipmast locust. The author also gives special recognition to the long interest of Henry Hicks of Westbury, Long Island, in this outstanding tree.

**B**LACK LOCUST was not present in the original forests of Long Island, N. Y., but was introduced there in colonial days. At the time of the Revolutionary War, Long Island was an important agricultural region and there was a good demand for fence posts both on the Island and in New York City. Locust was planted widely in western Long Island for post production as well as for special uses in ship construction, which was long an industry of first importance in this region. In addition to woodlot plantings, the locusts were set out on lawns and along lanes, roadsides, and fence rows. Today, Long Island consists largely of suburban towns, villages, and estates. The locust trees now are especially valued for ornament; on many estates, the buildings have been placed so as to take best advantage of the picturesque old locust groves and fence row stands.

Long Island farmers distinguish between two forms of *Robinia pseudoacacia* L., usually calling them white locust and yellow locust. The white form is sometimes referred to as soft locust, common locust, and gray, green, or black locust. The other form is known as hard or durable locust, Sand's locust, and Long Island yellow locust. In 1934, Dr. C. F. Swingle suggested that the yellow strain be called "shipmast" locust because of its tall, straight trunk (Figure 1). This common name was adopted by Dr. Oran Raber as the title of U. S. Dept. Agric.

Circular No. 379, in which publication it was given definite varietal status as *R. pseudoacacia* var. *rectissima*.

Detailed information on the identifying characteristics and special qualities of shipmast locust may be found in Dr. Raber's interesting publication. The present article deals with some high lights of the history of shipmast locust, and is also designed to give proper recognition to Henry Hicks, of Westbury, Long Island, for the valuable observations he has furnished on this locust variety. Mr. Hicks has been a staunch supporter of the principles of forestry and conservation, and throughout his long career as a nurseryman he has always found time for scientific observations and services in the field of biology.

When I first met Mr. Hicks in 1920, he told me the foresters would profit from a study of the Long Island yellow locust as a tree having exceptionally valuable qualities. Having occasion to go to Long Island in April 1924, I arranged to visit Mr. Hicks, and he spent the day in exhibiting many locust stands, old locust fences, and the reputed original parent trees of this variety, believed to have been planted in 1683, at Roslyn and Glen Cove. White and yellow locusts were seen growing together at a number of places and the superiority of the yellow variety was clearly evident.

On Mr. Hick's suggestion, I secured some yellow locust root-cuttings in 1924

and planted them in an experimental plot at Arlington Farm, Va. A number of these cuttings developed into rooted plants and convinced me that this tree could be propagated in this manner. It was also apparent that propagation of locust from root cuttings would require large-scale experiments before it could become economically practicable. This was outside of my field of work at that time and I did nothing further until 1933, when I was placed in charge of the Erosion Control Nursery unit of the Division of Plant Exploration and Introduction, Bureau of Plant Industry, and experiments were initiated by this unit looking to the economical propagation and wider use of shipmast locust. Dr. Swingle conducted the propagation experiments,<sup>1</sup> and Mr. Hicks, Dr. Raber, Dr. R. C. Hall,<sup>2</sup> Dr. F. C. Craighead, Dr. A. E. Longley, B. Y. Morrison, Knowles A. Ryerson, Dr. A. F. Blakeslee, R. B. Thornton, and others rendered valuable assistance in various other phases of the work with shipmast locust.

Henry Hicks, in an article on "Long Island Landscape Art" published in the *Glen Cove Echo*, 1934, wrote: "Long Islanders know two varieties of locust as follows:

"John Sands, born 1649, England; married Sybil Ray, Block Island; died 1712; sailed his ship to Virginia, broke the boom, replaced it with a locust trunk; found it strong and useful. On a later trip he brought trees or roots to his place at Sands Point, Port Washington, L. I.

"The yellow locust was extensively planted for fence posts and for pins for buildings and ships. A book published in England, Withers on the Acacia, over one hundred years ago tells of a farmer on Long Island who planted for each child ten acres of locust. For the daughters the locusts were sold for a dowry; for the sons a farm was bought. Some of Sands' original trees were planted at Washington Inn, Roslyn, and The Place at Glen Cove."

A paper on "The Black or Yellow Locust" by John S. Hicks of Roslyn, L. I. was read at the meeting of the American Forestry Congress at Cincinnati in April 1882, and published in the *American Journal of Forestry* for July 1883. He credits Capt. John Sands with bringing the yellow locust to Long Island from Virginia. "The History of Long Island" by Benjamin F. Thompson (1918) states:

"John Sands, with his brothers James and Samuel purchased part of Cow Neck

Name	Yellow locust Hard locust	White locust Soft locust Gray locust
Durability in ground	100 years	Perhaps one-third or one-half as long
Color of heart wood	Deep yellow	Pale yellow
Shape of tree	Straight Tall and narrow Single trunk	Crooked Low and wide Branching like an elm
Bark	Deep furrows	Shallow furrows
Color of bark	Dark colored	Lighter colored
Seed	No seed	Seed abundant
Propagation	Suckers after old trees cut, root cuttings	From seed Also suckers

<sup>1</sup>See Swingle, Charles F., Experiments in propagating shipmast locust, page 713, this issue.

<sup>2</sup>Refer to Hall's article as published in this issue.

(now known as Manhasset Neck). He was a seafaring man and carried on trade between Virginia and New York, and brought from the former colony some young locust trees, which being planted at Sand's Point, produced in the course of time nearly all the valuable timber of this kind since grown in the town and neighborhood. (Volume 4, page 391.)

"It is extensively cultivated between Flushing and Smithtown, being literally a mine of wealth to its respective owners. Fences here are mostly constructed of it, and almost every farmer has now his forest of locust of from 10 to 100 acres in extent." (Volume 3, page 192.)

How soon after settlement the early colonists planted the first black locust tree is not known. The original range of this tree was restricted to the Appalachian Mountain region, and Robin is credited with first planting it in France about 1601. Jamestown was settled in

1607, Manhattan Island in 1614, and Long Island in 1636, and it seems probable that for some years after these dates the settlers were too busy with clearing to be interested in tree planting. However, the most severe pioneer struggles were over by 1624 in Jamestown and by 1665 on Long Island so that farmers might then have been planting locusts.

No record of Captain Sands' voyages has been found, but it appears probable that he began his coastwise trading about 1668, at the time he built his house on Long Island. This house still stands, in excellent state of preservation, on the tract of land which was granted to Sands by the King of England after New York became English territory in 1664. Mrs. Ethel Watts Mumford furnished this information. Mrs. Mumford lived for some years in the old Sands house and wrote a short story, "The Manifestation of Henry Ort," about it, and the film version of this tale was photographed there. The date 1668 is carved on a foundation stone of the wing that constituted the original structure. In 1695 or 1696, Cap-



Fig. 1.—Grove of 65-year-old shipmast locust on Burling Estate, Centerport, L. I. Average 12½ inches d.b.h., 90 feet tall, 250 trees per acre.



Fig. 2.—Old fence posts of shipmast locust. The fifteen posts on the right are still usable after 110 years of service and are being sold to neighboring farmers at 50 cents each. D. S. Wooley, Lakeville, L. I., shown in photo, was born on this farm and saw the five posts on the left made and set in 1876. Mr. Wooley's grandfather deeded the farm to his son in 1815, at which time the older posts were set. The posts were taken up in 1925 when fields were thrown together, and most of the posts have been sold since then.

tain Sands purchased the northern tip of Sands Point, adjacent to his house, and established his two brothers there. This land is now in estates owned by W. R. Hearst, Conde Nast, and others. The graves of Captain John Sands and his wife are on the Nast estate, amid towering shipmast locust trees.

Extensive scouting for the original source of shipmast locust in the lower Chesapeake Bay region failed to locate any such trees. It would be desirable to find the original Virginia planting if it exists, in order to select the choicest possible material for extensive propagation of this strain. Mrs. Mumford states that Captain Sands made a voyage to China and got the tree there, but this seems improbable. It may be, however, that he got it at a point south of the Chesapeake or, less likely because of later settlement, in the upper Chesapeake Bay or Potomac River territory. In any event, it seems fairly certain that Captain Sands introduced shipmast locust on Long Island, and that the early farmers there appreciated its exceptional value, so that today the supply of this variety of locust is more abundant on Long Island than elsewhere in the United States.

It is not literally true that shipmast locust bears no seed. However, Dr. Raber's statement is correct that "seed pods (i. e., fruits) are extremely seldom found on shipmast trees, and if present at all occur so sparingly that they are very difficult to find. . . . Owing to this scarcity or absence of seeds, the shipmast locust is propagated only vegetatively by means of root cuttings and sprouts." Vegetative propagation has had the merit of maintaining shipmast locust as a pure strain for a period of approximately 250 years. Despite lack of seed, the farmers of western Long Island succeeded in planting it extensively. As a rule they dug small rooted sprouts collected locally from the

vicinity of shipmast locust trees. Occasionally the farmers collected roots a foot or two in length, placed them horizontally in furrows and covered them lightly with earth. Sometimes only a single row of sprouts were set out and the following year a furrow was plowed on either side of this row, cutting the roots of the young trees and causing them to send up sprouts. In this way the locusts gradually were spread over the entire field.

*Robinia pseudoacacia* is a general-purpose farm tree and has outstanding value for erosion control purposes. However, the common locust has so many undesirable qualities that many farmers object to planting it on their farm lands which have to be taken out of cultivation because of erosion damage. Shipmast locust overcomes many objections to use of black locust in erosion control operations because of its straighter trunk, greater resistance to borer-attack, and exceptional durability of its wood in contact with the soil (Figure 2). Possibilities of developing still better selections of black locust for erosion control uses are being investigated by the Soil Conservation Service in cooperation with the Bureau of Plant Industry.

In 1934, "The Land Program" of the Federal Emergency Relief Administration in cooperation with the Bureau of Plant Industry, established a nursery in North Carolina for production of shipmast locust from root cuttings collected on Long Island. This nursery was transferred to the Resettlement Administration in 1935. The conditions under which shipmast locust planting stock may be made available to the general public from this nursery, if at all, have not at present been determined. In any event, the supply of stock will be inadequate to provide for any general distribution before the fall of 1938.

# EXPERIMENTS IN PROPAGATING SHIPMAST LOCUST

By CHARLES F. SWINGLE

*Section of Conservation Nurseries, Soil Conservation Service*

Shipmast locust produces few or no seeds. Consequently the tree must be propagated by vegetative methods. A comprehensive study of this subject showed that shipmast and other locusts may feasibly be propagated by root cuttings. Such a method will doubtless cost somewhat more than seed propagation, and is therefore not recommended except in the case of certain desirable individual trees or strains. It appears to be the most practical method of large-scale propagation for the Long Island shipmast locust.

RECENT emphasis upon the black locust (*Robinia pseudoacacia* L.) for use in forestry and erosion control has focused attention upon certain phases of its propagation and especially upon the desirability of producing vegetatively certain outstanding types, in particular the Long Island shipmast locust.<sup>1</sup>

Though seeds constitute virtually the only means of propagation now employed for large-scale plantings, and undoubtedly will continue for many years as the chief source of supply, it is recognized that seed propagation, easy as it is, has several drawbacks. Although thus far given little attention outside ornamental horticulture, numerous strains of *Robinia* have been selected, named, and propagated by some vegetative means. It has been clearly established that the horticulturally desirable characteristics of most of these cannot be propagated true to type except vegetatively. Since in most cases relatively expensive ornamental trees in only limited numbers are involved, grafting has been employed.

Apparently the only known instance of forestry use of a particular strain of *Robinia pseudoacacia* is that of the Long Island shipmast locust. This locust has few or no good seeds and it has long been the custom to propagate this type by digging sprouts in an established grove. Such a method of increase while satis-

factory for small-scale use where at most a few hundred trees are required is wholly out of the question for obtaining plants by the million. Because of the desirability of finding some method of vegetative propagation adapted to cheap, large-scale production of shipmast and other outstanding types of locust, in the spring of 1934 extensive experiments were undertaken at Arlington Experiment Farm, Rosslyn, Va.

## MORPHOLOGICAL CONSIDERATIONS

When locust trees are cut down, or roots injured or exposed, new shoots appear, frequently in great profusion. Apparently the new shoots form from dormant invisible but preformed rudiments which naturally occur wherever branch roots emerge from the older root. Unlike plants which develop root-borne buds only from callus tissue, the severance of the root is not essential in locust to the pushing out of these preformed buds into functioning shoots. In fact, in locust the cut surface seems merely a necessary evil—in no case have shoots been seen to arise from the callus at the cut. Figure 1 shows an example of sprouts arising on a long locust root exposed to moist air. (See Priestley and Swingle, Vegetative Propagation from the Standpoint of Plant Anatomy, U. S. Dept. Agr. Tech. Bull.

<sup>1</sup>See Detwiler, S. B. The history of shipmast locust, page 709, this issue.

151, 1929, for a discussion of the various types of adventive shoots.)

#### EXPERIMENTS WITH ROOT CUTTINGS

Although there was apparently no definite record of successful propagation of black locust by root cuttings, this method seemed to offer the greatest possibilities. In April, large quantities of roots of shipmast locust were dug at various places on Long Island, N. Y. The untrimmed roots packed in moss in wooden boxes, were shipped back to Arlington Farm, made into cuttings and planted under four different soil conditions. The cuttings were then handled so far as possible according to the best nursery practices. Other root material was obtained from Virginia, Ohio, Iowa, and New York. Cuttings of diverse lengths, diameters, and ages were made and planted from April to September, and subjected to various treatments at planting time and in the field. All material was dug in March 1935, and the records at digging time were made by F. J. LeClair.

#### SIZE AND AGE OF ROOTS

Table 1 gives the data for horizontally planted roots with respect to the influence of diameter of cuttings and age of parent grove. Table 2 gives the corresponding data with respect to size effect for one age-type only, of cuttings planted upright.

Table 1 indicates emphatically that the age of roots has a very important bearing upon the yield of sprouts. This is in accordance with the ideas of most propagators and hardly needs comment at this place. An important point brought out, however, is that the very large roots—over  $1\frac{1}{2}$  inches in diameter—gave a considerable yield of sprouts. In this respect locust differs markedly from apple and many other species which can be readily propagated from vigorous 1-year roots but not from older roots. The im-

portance of this point should not be overlooked, for it offers a feasible means of getting a start from desirable old trees.

Tables 1 and 2 both emphasize the importance of using roots of proper size for cuttings. Without exception, in all these experiments roots less than  $\frac{1}{4}$  inch in diameter gave uniformly poor results. While the yield of the larger roots was but little less than that obtained with roots of approximately  $\frac{1}{2}$  inch diameter, roots over 1 inch are hard to handle and, all things considered,  $\frac{1}{4}$  to 1 inch seemed to be the best practical diameters to use (Figures 2 and 3).

There was also evidence obtained in another series of root cuttings not here reported in detail, that different individual trees displayed marked differences in propagability.

#### TIME OF DIGGING ROOTS AND PLANTING CUTTINGS

No table is necessary to show the relative effects of spring and summer planting. The results obtained with material planted before the 7th of May, are shown in Tables 1 to 5, and Figures 2 and 3. Some 20,000 cuttings were planted in June and July from roots dug after top growth was in evidence. Approximately only 1 per cent of these lived at all, and not a single one of them made growth comparable to the earlier planted material.

There seemed to be no doubt whatever that roots for use as root cuttings must be dug before they had given up their stored food to the new top growth.

#### ORIENTATION

Apparently the orientation of the root pieces in relation to gravity had little effect on the ability to throw sprouts. On the other hand, practical considerations emphasize that the roots should be planted upright, although this is not brought out in Tables 1 and 2 where

TABLE 1

EFFECT OF AGE AND OF ROOT DIAMETER, ON YIELD OF SHIPMAST LOCUST ROOT CUTTINGS

Roots dug on Long Island, N. Y., April 17-21, 1934. Cuttings made and planted, Arlington Farm, Va., April 28-May 7. Dug March 1-5, 1935. All cuttings planted horizontally, on sandy loam.

Designation and age of trees in grove	Diameter of roots in inches								Total	
	$\frac{1}{8}$ - $\frac{1}{8}$	$\frac{1}{8}$ - $\frac{3}{8}$	$\frac{3}{8}$ - $\frac{1}{4}$	$\frac{1}{4}$ - $\frac{3}{8}$	$\frac{3}{8}$ - $\frac{1}{2}$	$\frac{1}{2}$ - $\frac{3}{4}$	$\frac{3}{4}$ -1	1-1½	1½ up	(all sizes)
Long Island 3										
60 years										
No. planted .....	101	193	98	131	90	66	51	48	43	821
No. usable trees .....	1	---	2	4	6	10	8	8	4	43
Per cent usable trees ..	1.0	0.0	2.1	3.0	6.8	15.1	16.0	16.7	9.3	5.2
Long Island 4										
60 years										
No. planted .....	310	302	141	126	114	55	50	37	23	1158
No. usable trees .....	---	---	1	9	5	5	12	20	3	55
Per cent usable trees ..	0.0	0.0	0.6	7.1	4.0	9.1	24.0	54.1	13.0	4.8
Long Island 5										
5 years										
No. planted .....	350	326	246	265	157	47	47	42	---	1480
No. usable trees .....	2	25	45	80	112	36	38	27	---	365
Per cent usable trees ..	0.5	7.7	17.9	30.2	71.3	76.0	80.8	64.3	---	24.6

TABLE 2

EFFECT OF DIAMETER OF CUTTING ON YIELD

Shipmast locust root cuttings, 3 to 4 inches in length, planted upright. Roots dug on Long Island, N. Y., April 17-21, 1934. Cuttings made and planted Arlington Farm, Va., April 28-30, on sandy loam. Dug March 1-5, 1935. Roots from trees approximately 5 years old.

	Diameter of roots in inches					
	$\frac{1}{8}$ - $\frac{1}{8}$	$\frac{1}{8}$ - $\frac{3}{8}$	$\frac{3}{8}$ - $\frac{1}{4}$	$\frac{1}{4}$ - $\frac{3}{8}$	$\frac{3}{8}$ - $\frac{1}{2}$	$\frac{1}{2}$ - $\frac{3}{4}$
No. planted	620	617	1009	839	764	578
No. usable trees	19	64	231	247	221	155
Per cent usable trees	3.1	10.3	22.9	29.4	28.9	26.9

TABLE 3

INFLUENCE OF SOIL TYPE ON YIELD OF ROOT CUTTINGS

Roots from trees 5 years old, dug April 17-21, 1934. All roots planted horizontally, April 27-May 7. Trees dug March 1-5, 1935.

Location at Arlington Farm	Soil type	Diameter of root (inches)	Number of roots planted	Number of usable trees dug	Per cent of usable trees
Section V	Heavy loam	$\frac{1}{4}$ - $\frac{3}{8}$	314	48	15.4
Section V	Heavy loam	$\frac{3}{8}$ - $\frac{1}{2}$	366	152	41.6
Section V	Heavy loam	$\frac{1}{2}$ - $\frac{3}{4}$	255	78	30.6
Section V	Heavy loam	$\frac{3}{4}$ -1	40	16	40.0
Section W	Sandy loam	$\frac{1}{4}$ - $\frac{3}{8}$	265	80	30.2
Section W	Sandy loam	$\frac{3}{8}$ - $\frac{1}{2}$	157	112	71.3
Section W	Sandy loam	$\frac{1}{2}$ - $\frac{3}{4}$	47	36	76.0
Section W	Sandy loam	$\frac{3}{4}$ -1	47	38	80.8

the larger sizes show a slightly higher yield with horizontally planted roots. The necessity for upright planting was first observed only after growth had ceased in the fall and the leaves had dropped. Then it was apparent that the horizontally planted roots had almost without exception yielded a distinctive bushy type of growth. On digging it was found that though usable, relatively few of the sprouts from the horizontal block were really first grade; roots were sparse on the new growth and it was difficult satisfactorily to incorporate the old root into the new tree.

Hence in spite of a slightly higher total yield obtained with horizontally planted material, upright planting seemed to be

decidedly better. Of course, with upright cuttings it is essential to place that end up which grew closest to the parent shoot.

#### SOIL DIFFERENCES

Tables 3 and 4 bring out the point that heavy soils are unsuited for locust root cuttings. Not only was the survival much lower on the heavier soils, but the trees obtained were much less usable. On heavy fertile soil the growth of the tops was favored, while the root system—the really important part of a tree for forest planting—was shallow and but weakly developed. Windstorms in September, accompanied by heavy rain, up-

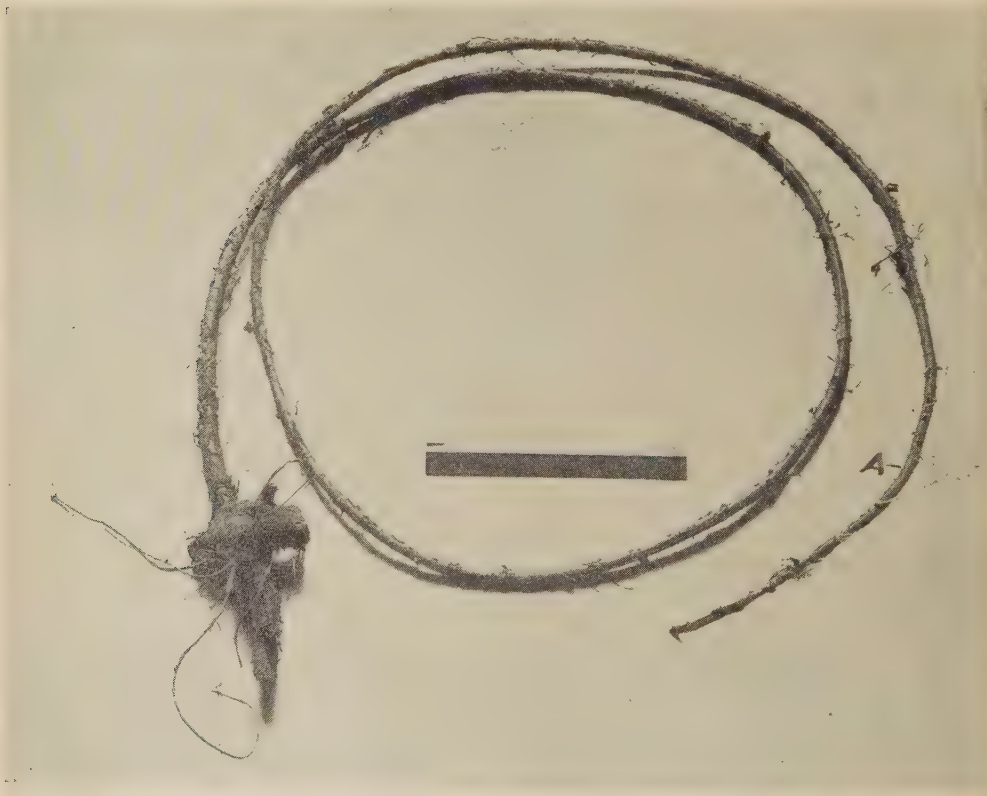


Fig. 1.—Locust root, still attached to the 5-year-old sprout on which it grew, kept without soil or packing in a dark storage cellar from the time of digging in April until photographed in September. Throughout this period, live sprouts (as shown at A) appeared along the entire length of root.



Fig. 2.—Results with cuttings 3 to 4 inches long, of the following maximum diameter in each row (left to right):  $\frac{1}{8}$ ";  $\frac{3}{16}$ ";  $\frac{1}{8}$ ";  $\frac{1}{4}$ ";  $\frac{3}{8}$ ". Roots under  $\frac{1}{4}$ " diameter gave poor results; above this size the growth was satisfactory.



Fig. 3.—One summer's growth of shipmast locust from root cuttings between  $\frac{1}{4}$  and 1 inch in diameter.

rooted many individuals on the heavy soil, but none on the sandy land.

Cutting back overgrown tops in full growth, in an effort to keep the plants within bounds, merely resulted in the death of most plants so treated.

#### SPECIAL TREATMENTS

*Paraffin.*—Most of the material in these experiments was dipped in a mixture of 10 per cent rosin and 90 per cent paraffin. It was believed that this treatment might prove helpful in excluding rot organisms and would not be injurious.

As brought out in Table 5, however, (the only experiment carried out to test this question) there was considerable evidence that this treatment was somewhat injurious. Certainly there is nothing to indicate that dipping was worth the extra labor and expense involved.

*Influence of Bacterial Inoculation.*—Several lots of cuttings were treated with preparations of black locust nodule bac-

teria, using both a commercial preparation and one prepared by the Division of Soil Microbiology of the Bureau of Plant Industry. The cuttings in these tests were not planted until the middle of June, and all gave uniformly poor results. There was no indication whatever of any effect of the inoculation. Neither was there any effect noticed with early planted cuttings treated the middle of June when the largest shoots had attained a height of approximately 2 feet. The extremely vigorous growth obtained with all material in this block indicated that lack of nodule bacteria was not a factor, and this diagnosis was confirmed at digging time.

#### EXPERIMENTS WITH SOFTWOOD CUTTINGS

On July 30, shoots of shipmast locust from the root-cutting propagation blocks were taken from the nursery and made into softwood cuttings. All of these 200 cuttings rotted within 3 weeks without rooting. On August 16 another lot of

TABLE 4

##### INFLUENCE OF SOIL TYPE ON YIELD OF ROOT CUTTINGS

Roots from trees 60 years old, dug April 17-21, 1934, planted April 27-May 7. All roots planted horizontally. All roots 1-1½ inches in diameter. Dug March 1-5, 1935.

Location at Arlington Farm	Soil type	Number of roots planted	Number of usable trees dug	Per cent of usable trees
Section T	Very heavy loam	38	2	5.3
Section V	Heavy loam	48	4	8.3
Section W	Sandy loam	37	20	54.1

TABLE 5

##### EFFECT OF PARAFFIN TREATMENT ON STAND OF ROOT CUTTINGS

Roots dug on Long Island, N. Y. (L.I.5), April 17-21, 1934. Cuttings made, dipped in mixture of 90 per cent paraffin and 10 per cent rosin, and planted Arlington Farm, Va., April 27 to May 5. Cuttings 3 to 4 inches in length, all sizes together.

Soil	Treatment	Orientation	No. cuttings planted	No. usable trees March, 1935	Per cent usable trees
Heavy loam	paraffin	horizontal	288	28	9.9
Heavy loam	check	horizontal	267	41	15.3
Sandy loam	paraffin	upright	808	87	10.7
Sandy loam	check	upright	720	61	8.5
V. light sandy loam	paraffin	upright	826	83	10.0
V. light sandy loam	check	upright	690	108	15.8
	Average all paraffin		1,922	198	10.4
	Average all check		1,677	210	12.5

softwood cuttings was made from sprouts in the nursery. Although this material was from the same source and looked in all respects like that previously used, and in fact most of it also rotted, four of these latter 200 cuttings were rooted by September 4 (Figure 4).

On August 17 cuttings were taken from greenhouse-grown shoots developed on rootcuttings planted April 3. Nine out of 230 cuttings rooted by September 5 (4 per cent). In all the cuttings there was no rooting or callusing except on cuttings which had maintained their leaves. All of these were moderately vigorous stem cuttings, with one or two leaves. One of those that rooted was a heel cutting, one a mallet cutting, the others simple softwood cuttings. Most material which did not callus or root had rotted within 3 weeks.

No leaf cutting, of several dozen tried, gave any promise.

These experiments with softwood cutting propagation of locust, indicated that this method had theoretical value but under the conditions tried was far below that offered by root cuttings.

#### RECOMMENDATIONS

As a result of these experiments, the following recommendations regarding the propagation of shipmast locust seem to be indicated:

*Sprouts*.—1. The surest, quickest, and most satisfactory method for small-scale propagation is digging the requisite number of young sprouts from a carefully selected old grove. This must be done during the dormant season, the roots protected from freezing and drying, and if the sprouts are not to be planted in their permanent grove location immediately, they should be stored under cool, moist conditions. In any case they should be planted before bud growth is much in evidence. Tops should be cut back to between 3 and 6 inches.

*Root Cuttings*.—2. Rootcuttings offer the only present-known feasible means for large-scale propagation of shipmast and other locust varieties which do not reproduce true to type or at all from seeds. This method costs two or three times that of the most efficient seedling propagation methods and accordingly is not to be recommended except for the increase of superior types.

3. Roots for use as cuttings should be from  $\frac{1}{4}$  to 1 inch in diameter and as young as possible, preferably of the previous season's growth, and from trees as young as possible.

4. Older roots as well as roots from much older trees may also be used to obtain the start of a given type.

5. Roots *must* be cut from the parent plant while the tops are dormant.

6. Roots can be made into cuttings



Fig. 4.—Softwood cuttings of black locust rooted in the greenhouse in August, using bottom heat.

and planted any time after they are obtained, until new bud growth is beginning to show in the spring.

7. Roots at all times must be protected from drying and freezing.

8. The most desirable type of roots are those obtained in the nursery when one year's crop of rooted cuttings is dug and trimmed.

9. Cuttings 3 to 5 inches in length are most satisfactory. They should be planted upright with the proper relation to their former habit of growth. To maintain this orientation the roots must be so handled, both before and after making into cuttings that there is no mistake about which end is "up" and which "down". After making into cuttings, this is best done by holding in bundles of 50 or 100, using rubber bands and inserting a nail in each bundle to show the planter which end is "up".

10. The locust root-cutting nursery must be situated on well-drained, sandy soil, preferably with some source of irrigation water available for the first few weeks. Relatively infertile soil favors a maximum yield of usable stock.

11. Under conditions of horse cultivation 25,000 to 150,000 cuttings can be planted per acre. Yields of 25 per cent can be expected under proper conditions, with roots of all ages. With one-year-old root cuttings, a higher percentage should produce usable stock. Under greenhouse conditions, one year old roots yielded 92 per cent rooted plants.

*Other Types of Propagation.*—12. Locust can also be propagated by softwood cuttings made late in the summer, by hardwood cuttings, by budding and other types of grafting, and by division of the crown. None of these methods however is recommended for large-scale operations.

# GROWTH AND YIELD IN SHIPMAST LOCUST ON LONG ISLAND AND ITS RELATIVE RESISTANCE TO LOCUST BORER INJURY

By RALPH C. HALL

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A comprehensive study of the shipmast and the common locust shows that the former is more resistant to the locust borer and longer lived than the latter. The growth rate of the shipmast locust in the Central States compares very favorably with that of the common locust. In brief, the shipmast locust appears to be a tree of considerable merit and it probably will be much more widely planted when its merits become better known and when planting stock becomes generally available.

UNDER the present E.C.W. program of erosion control, a very large acreage of black locust (*Robinia pseudoacacia* L.) is being planted throughout the United States. Except for the propagation of shipmast locust (*R. pseudoacacia* var. *rectissima* Raber), very little attention has been given to the selection of the more desirable varieties of locust for this erosion-control work. A very high percentage of the locusts have been planted on portions of farms incapable of producing a cash crop other than through the growth of trees. For that reason it is highly desirable that the trees planted on such areas be of the best varieties available. A large proportion of the locust seedlings produced to date have been from seed collected in Europe without regard to locality or quality of the seed trees. Even where seed has been collected in the United States, proper care has not been exercised in selecting desirable seed trees, and much of the seed has been collected from small, inferior trees, many of which have been seriously injured by the locust borer. Through the use of seeds from inferior parents, it is reasonable to expect a high percentage of inferior, slow-growing stands of locust. Recently developed sources of locust seed in the intermountain region of the Northwest promise better seed than was previously used, but greater hope for superior locust stock lies in clonal or pure-line propagation.

## STUDY OF THE LOCUST BORER IN THE CENTRAL STATES

A comprehensive study of black locust and the locust borer (*Cyrtene robiniae* Forst.) has been under way at the Central States Forest Experiment Station since June 1931. During that time more than 400 sample plots have been established in the following states: Connecticut, Illinois, Indiana, Iowa, Kentucky, Maryland, Michigan, Mississippi, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia. Many of these plots have been established in cooperation with L. F. Kellogg, of that station, in his study of growth and yield of black locust. This wide selection of plots covers most of the geographical and ecological conditions under which the locust borer develops as an important insect pest.

The results of this intensive study indicate that a very close correlation exists between locust borer damage and the vigor of the tree. This relationship is an inverse one, with borer damage declining as the vigor of the tree increases. Several previous investigators have suggested that certain varieties of black locust might be resistant to locust borer injury. While the present investigation has not clearly demonstrated this point, it has uncovered numerous trees that seemed to show a marked resistance to the borer. Frequently, however, the physical form of the

variety in question appears to be a very important factor in its resistance to borer injury. Only in rare instances does the locust borer actually kill the tree. The death of the tree results usually from its being broken by the wind at the point of serious attack. In a tree with a straight bole, with few large limbs or crotches, locust borer attack is not nearly so serious as in a tree with a crooked bole. In other words, a tree that deviates even slightly from the vertical is much more easily broken after injury than one that is truly vertical.

#### THE STUDY ON LONG ISLAND

A special investigation of growth and yield in shipmast locust on Long Island, and its injury by the locust borer, was conducted during April 1935 by the author assisted by H. J. MacAloney, of the Northeastern Forest Experiment Station. The growth of shipmast locust was observed under a wide variety of conditions. Nineteen intensive sample plots were established in plantations ranging from 26 to 80 years of age, and on these plots records of individual trees were obtained to determine the amount of locust borer damage on trees under a variety of site conditions.

A comparison was made of the borer injury on these trees and on the common form of black locust, and it was found that, although the number of attacks on the two varieties was relatively the same, the resultant injury to shipmast was very much less than to the common locust. The explanation may lie in the difference in form of the two strains, or it may be more difficult for the borer to penetrate the trunk of the shipmast locust than of the common locust, possibly owing to physical and chemical differences in the wood. On Long Island there is abundant local evidence that shipmast locust wood is much more durable than that of the common locust. During the survey nu-

merous stands of common locust that had been completely destroyed by the locust borer were noted, but not a single stand of the shipmast locust. Both forms of locust make unsatisfactory growth on poor acid soils, but the relative resistance to borers remains about the same even under various conditions.

*Rate of Growth.*—In rate of growth shipmast locust on Long Island compares very favorably with that of the varieties that occur in the Central States, as may be noted from Figure 1. The rate of height growth on the Long Island plots is better than that of trees of the same age on the average plots in the Central States. This is especially true of trees that are more than 50 years of age. However, a true comparison of the older trees is difficult to obtain owing to the small number of samples in the older age classes in the Central States.

Shipmast locust appears to have a greater span of life when in pure plantations than does any other variety of locust in which sample plots have been established. Numerous fully stocked plantations of shipmast locust over 50 years of age were observed on Long Island. There are practically no fully stocked plantations of black locust over that age in the Central States, although this is largely because planting was not started until later. It is not safe to generalize too much on this point, because it may be that Long Island is a better site for locust than are areas in the Central States. It is unfortunate that so few plantations of common locust occur on Long Island within the local range of shipmast, because that would offer the only fair basis for comparison. However, some small stands and many isolated trees of common locust permit some comparison with the shipmast locust,

*Relationship Between Tree Vigor and Borer Injury.*—As was noted previously, there appears to be a close relationship between tree vigor and injury due to the

locust borer. In this paper site index is used to indicate vigor, and injury index is employed as a numerical basis for assessing injury. The scale of injury index is as follows: 0, no injury; 1-33, light injury; 34-66, medium injury; 67-100, severe injury. Each tree in the sample plots was given an injury index figure based upon the number of emergence holes, and from these figures the average injury for the entire plot was calculated. The relationship between site index and injury index in shipmast locust and in the Central States locust is apparent in Figure 2. It may be noted that for a given site index the injury index is very much less in shipmast than in the other varieties. The average values for the two curves are given in Table 1. From this it may be seen that for a site index of 50 in shipmast locust the injury index is 30, while in Central States locust it is 80, which means a difference between light and severe injury. As the site index increases, the difference is reduced until at 100 the difference is only 15.

*Yield.*—The yield of the sample plots that have been established in the Central States has been compared with the yield of shipmast locust on Long Island. Again, as in the case of growth, comparisons are rather difficult owing to the uneven distribution of plots in the two localities. These data for yield are presented in Table 2, tabulated according to five-year age groups.

TABLE 1

RELATION OF SITE INDEX TO BORER INJURY IN  
SHIPMAST AND CENTRAL STATES LOCUST

Site index in feet	Average injury index in per cent	
	Shipmast locust	Central States locust
50- 59	30	80
60- 69	21	65
70- 79	14	50
80- 89	8	38
90- 99	3	26
100-109	1	16

It may be noted from this table that the yield of posts and in cubic or board foot volume appears to be slightly higher in the Central States plots up to about 40 years, when the Long Island plots surpass those in the Central States. This may represent a real difference in the two localities or it may be due to the uneven distribution of the plots.

In the absence of local yield tables for locust on Long Island, Kellogg's tables, for planted black locust in the Central States, were used. Because of its superior form, shipmast locust would be expected to show an actual yield much greater than that indicated from the Central States tables. Shipmast locust has less taper, fewer crooks, and smaller limbs than the common varieties of locust which were used in the construction of the Central States yield tables. For these reasons the yields as shown in this paper for the shipmast locust are considered to be very conservative.

#### GROWTH AND SURVIVAL OF FIELD-PLANTED SHIPMAST

The problem of resistance of various desirable varieties of black locust to borer injury can best be approached by planting these on a wide variety of sites, especially on those areas where it is expected that borer damage will be severe. These plantings should be followed by periodic inspection for at least ten years to determine the attack and survival on all the varieties to be tested.

The Bureau of Entomology and Plant Quarantine is cooperating on the problem of selecting desirable borer-resistant varieties, and during the spring of 1935 about 9,000 shipmast locusts were planted on twelve permanent sample areas in Ohio, Indiana, Illinois, and Iowa. They were planted in alternate rows with seedling stock raised in Ohio and Indiana.

The data from only one area, containing four 0.1-acre sample plots, have been

TABLE 2  
COMPARISON OF YIELD OF POSTS, MERCHANTABLE VOLUME, AND BOARD FEET IN SHIPMAST LOCUST ON LONG ISLAND AND BLACK LOCUST IN THE CENTRAL STATES

Average age in years		Number of plots		Yield of posts <sup>1</sup>				Yield in merchantable volume <sup>2</sup>				Yield in board feet <sup>3</sup>			
				Number per acre		Average number per acre per year		Cubic feet		Average cubic feet per acre per year		Volume		Volume per acre per year	
Long Island	Central States	Long Island	Central States	Long Island	Central States	Long Island	Central States	Long Island	Central States	Long Island	Central States	Long Island	Central States	Long Island	Central States
26	27	1	22	900	1,100	35	41	1,400	1,800	54	67	3,600	4,100	138	152
32	32	2	5	1,100	1,300	34	41	1,900	2,000	59	62	4,300	4,900	134	153
37	38	4	4	2,100	2,300	57	60	3,200	2,900	86	76	7,000	10,400	189	274
43	43	3	2	3,100	1,400	72	33	3,600	2,200	84	51	10,700	6,000	249	140
48	49	4	2	3,300	2,700	69	55	4,000	3,300	83	67	15,100	11,300	315	231
53	---	1	---	3,100	---	58	---	3,900	---	74	---	14,000	---	264	---
65	---	2	---	7,400	---	114	---	7,600	---	117	---	40,000	---	615	---
80	---	2	---	7,300	---	91	---	7,300	---	91	---	36,000	---	450	---

The above table of yields of posts, merchantable volume and board feet has been computed from L. F. Kellogg's mimeographed tables in the form of Station Notes, U. S. Dept. Agr., Forest Service, Central States Forest Experiment Station, Columbus, Ohio.

<sup>1</sup>Preliminary table of post contents, plantation black locust. Station Note 13, July 15, 1934.

<sup>2</sup>A black locust volume table for contents in merchantable cubic feet. Station Note 11, April 17, 1934.

<sup>3</sup>A black locust volume table for contents in board feet. Station Note 9, March 29, 1934.

completely analyzed for 1935 and 1936, although height and survival records have been obtained for the other eleven areas. These four plots are located in southeastern Illinois, near Elizabethtown. In addition to furnishing data on resistance to locust borer attack and injury, these plots are expected to contribute information of a silvical nature. Records for the completed area are given in Tables 3 and 4. On this area the ground was given various treatments before the stock was planted, and in addition part of the stock was treated by top pruning. On the remaining areas in the Central States no treat-

ment was given to the ground or the stock. The shipmast stock used on this area came from material propagated by root cuttings at Arlington Farm, Virginia, by the erosion control nurseries of the Bureau of Plant Industry in 1934. Much of this stock was drastically root-pruned when it was dug. On many plants not a single feeding root remained, giving them the appearance of golf clubs rather than trees. All the stock was top-pruned at about 3 feet to facilitate shipping. Figure 4 illustrates the general appearance of the stock that was planted on this area.

The seedling locust trees of the common

TABLE 3

COMPARISON OF SURVIVAL IN PLANTING STOCK OF SHIPMAST AND COMMON LOCUST IN 1935 UNDER VARIOUS METHODS OF TREATMENT REPRESENTING FOUR 0.1-ACRE SAMPLE PLOTS

Treatment	Number of trees		Survival per cent			Significance of results	
	Shipmast	Common	Shipmast	Common	Difference	$\chi^2$	P
Unpruned:							
Not mulched .....	88 <sup>1</sup>	94 <sup>3</sup>	89	92	3	0.4	0.50
Mulched .....	71 <sup>1</sup>	85 <sup>3</sup>	86	89	3	.4	.50
Top-pruned: <sup>2</sup>							
Not mulched .....	99	119	93	80	13	6.6	.01
Mulched .....	76	93	91	89	2	.3	.60
All treatments .....	334	391	90	87	3	1.9	.20

<sup>1</sup>This stock had part of the top removed at about 3 feet above ground before it was shipped.

<sup>2</sup>Topped at about 3 inches above ground after planting.

<sup>3</sup>Top undisturbed.

TABLE 4

COMPARISON OF HEIGHT GROWTH BETWEEN FIELD-PLANTED SHIPMAST AND COMMON LOCUST FOR 1935 AND 1936 ON FOUR 0.1-ACRE SAMPLE PLOTS RECEIVING DIFFERENT TREATMENTS

Treatment	Season	Average height growth in feet			Significance of results	
		Shipmast	Common	Difference	t	p
Unpruned:						
Not mulched .....	{1935	1.00	0.60	0.40	2.3	0.02
	{1936	1.03	1.26	.23	1.6	.10
Mulched .....	{1935	2.15	2.25	.10	1.1	.30
	{1936	2.60	3.06	.46	2.1	.05
Top-pruned:						
Not mulched .....	{1935	2.08	1.33	.75	5.4	.01
	{1936	1.35	1.30	.05	.1	.90
Mulched .....	{1935	4.33	3.42	.91	2.4	.02
	{1936	3.12	2.72	.40	1.4	.10
All treatments .....	{1935	2.33	1.86	.47	2.2	.03
	{1936	1.88	1.93	.05	.1	.90

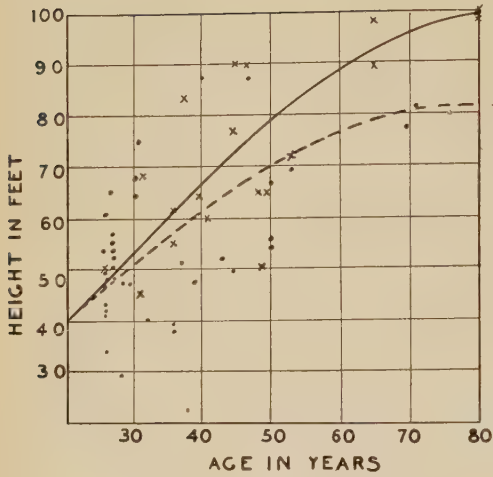


Fig. 1.—Comparison of height growth in shipmast locust on Long Island with that in other varieties of locust in the Central States. Crosses and unbroken line represents shipmast locust; dots and broken line, Central States locust.

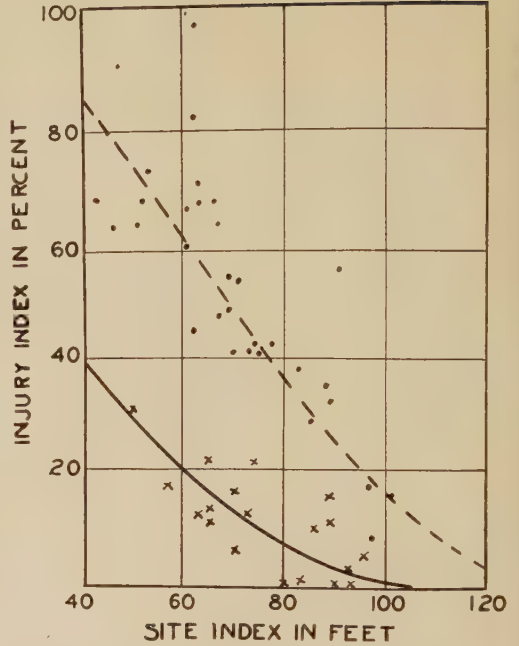


Fig. 2.—Comparison of locust borer injury in shipmast and Central States locust. Crosses and unbroken line, shipmast locust; dots and broken line, Central States locust.

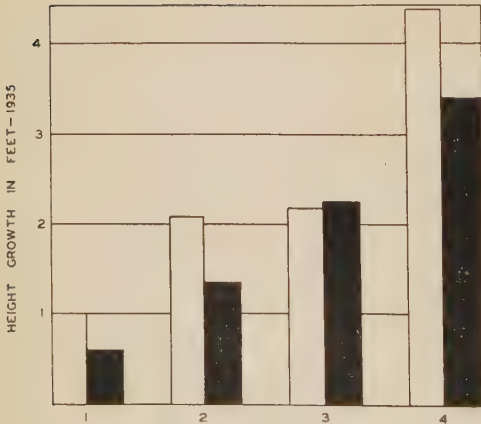


Fig. 3.—A comparison of growth of root propagated shipmast locust planting stock with that of seedlings stock of common locust, 1935. Open bars, shipmast; solid bars, seedling: 1 unpruned, not mulched; 2 top pruned, not mulched; 3 unpruned, mulched; 4 top pruned, mulched.

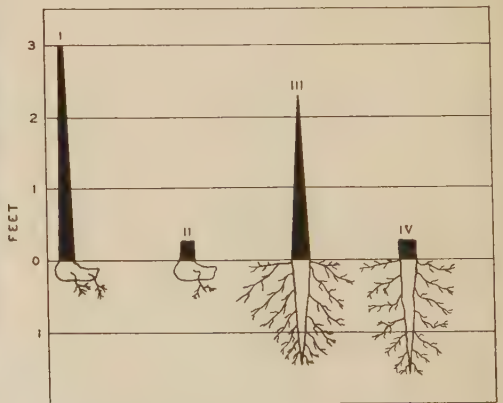


Fig. 4.—A diagrammatic sketch of shipmast and seedling planting stock: I shipmast unpruned; II shipmast, top pruned; III seedling, unpruned; IV seedling, top pruned.

variety used for checks were obtained from a C.C.C. nursery at Loogootee, Indiana, and represented the largest stock available. It developed that the shipmast stock was so much larger than the seedlings that comparisons of growth for the first two seasons following planting may be meaningless. Figure 4 illustrates the relative size of the shipmast and seedling stock.

There appears to be no significant difference in the survival of the two classes of stock except for the treatment top-pruned, not mulched (Table 3), where the shipmast stock showed a significantly higher survival than did the common stock. During 1935 the shipmast stock appears to have made significantly greater height growth than the common locust (Table 4 and Figure 3). In comparative growth during 1936 little difference was noted between the two kinds of stock.

In this series of four plots shipmast locust has shown a significantly greater initial height growth for 1935 and about the same average growth for 1936 than the common variety with which it was associated. No definite conclusions are justified, however, until all the data from the remaining areas have been analyzed.

#### SUMMARY AND CONCLUSIONS

During a comprehensive study of black locust and the locust borer at the Central States Forest Experiment Station since June 1931, more than 1,000 plantations have been examined. Of the varieties studied in this large number of samples, shipmast locust stands out as being one of the most desirable yet encountered. In view of its many superior qualities, it would appear advisable to give this and other desirable varieties more consideration in future planting programs.

A study of growth, yield, and locust borer injury in shipmast locust on Long Island was begun in April 1935. Shipmast locust was found to be much more resistant to the locust borer than the common locust of Long Island or other varieties of black locust in the Central States. Shipmast locust appears to have a longer span of life than other varieties studied. The growth and yield compare very favorably with those of other varieties in sample plots established in the Central States. The growth and survival of root-cuttings stock of the shipmast variety compare favorably with those of seedling locust with which it has been planted in the field.

## SOME BUSINESS ASPECTS OF FORESTRY

By E. A. STERLING

With nearly 80 per cent of the acreage of commercial forest land in private ownership, and with but infinitesimal scattered areas of such privately owned land under sustained yield management, many competent observers believe that the next important step in forestry will be congressional authorization of joint public and private effort in the establishment of cooperative sustained yield forest units. The author focuses attention on some of the financial obstacles which at present face the forest industries, and discusses the realities involved in possible governmental participation in, or regulation of, private forest management.

**A**BOUT everything seems to have been said about the present forest situation, except how the individual owner can maintain a permanent forest business. The benefits of a sustained yield basis of private operation are so apparent there is no question of endorsing the main objectives. It is like saying that the Golden Rule should be the guiding precept of men and nations.

It is not so much a question of what needs to be done as of what it is possible to do. It is not what the individual owner would like to do to protect himself and his own people but what he can afford to do. Upon the aggregate ability of individuals to do something different rests the future of an industry and of the reforms that affect public welfare.

What then is the answer? In the past it has generally been considered impractical to practice sustained yield as a business enterprise. Have conditions changed so that the obstacles that kept forestry out of the woods can be overcome? The realities that comprise the industrial and economic viewpoint have not greatly changed. Is there then some new way of reconciling them with the social and academic requirements that are insisted upon? No one can be more anxious than the individual owner to perpetuate his forest production and his business, and with them his community and the industry.

Outside of the Pacific Coast one certain change is that new timber stands for liquidation are few and of inferior quality.

The moving on process is over in the South and East. This means either the decline of the industry or much more intensive management and utilization of what is left, plus concerted action in keeping the better forest lands productive. This leaves the vital question of whether it can be made to pay as a private investment, under some modified program of individual or corporate management. To establish such permanent forest enterprises leaves open all the questions of how the physical and economic factors are to be handled in such a way so as to attain these ends. This is not the place to look for the answer.

The experimental results indicate that selective cutting costs less per M, improves grades and by leaving a growing forest makes the land more valuable. The practical operator wants to know how he can afford to cut over a greater area, curtail volume, incur the higher cost per acre and the greater expense for roads and other permanent improvements. It all depends upon what can be worked out for the individual property and conditions but if they are favorable the gain from handling larger logs and higher grades is often a surprising advantage. It is on just such things as the relation of log sizes to grades and values that lumbermen have missed some of their opportunities.

The small properties and operators are a problem in themselves. Not much can be done with the shifting, shiftless, and speculative, but others, with good intent,

have nothing left to work on. Nature may grow another crop but the owner cannot afford to wait. For the larger holdings, it is a matter of sharp pencil, an open mind and dollars and cents. The stability and confidence desired and required will in turn create these essentials and to the extent that economic security can be attained, social security will take care of itself.

It is the diversity of conditions and ownership that upsets desired objectives. The small, unorganized producers probably have the right to do the best they can as well as the big fellows, but it does not make for stabilization in industry or regions. At the same time, it is the individual operator, willing to make a modest living without counting overhead, who can best mop up and closely utilize the scattered stands that should give way to new growth.

For a real tough problem consider a southern saw mill operation that is about cut out, with little left except an acreage of cut-over land in various stages and a community that has been dependent upon the operation for many years. Reserves, if any, have probably been greatly reduced by the depression, the remaining assets are likely a family ownership or closely held group and those who built up the business naturally feel entitled to rest and retirement. Yet there are the land holdings and the dependent employees. For a very few, a paper mill may provide new life; for others a modified operation may extend production a few years; but for none can general rules apply, for it is only upon complete knowledge and analysis of each property and status of ownership that the best policy can be determined.

The strongly held, well financed and ably managed properties will not only find but lead the way. They are competent to do their own worrying and probably if they had it to do over again would have been practicing some form of

continuous yield many years ago. Even without the gift of always doing the right thing, they made and spent their own money, did a real two-fisted job in developing the forest industries and produced wealth and gave employment under the accepted rules of a square deal that made this country a pretty good place to live in. If this was a creaky horse and buggy stage, it remains to be seen whether a new stream-lined contraption will bog down in the realities of every-day timberland operations.

Despite the same old obstacles, there are, no doubt, opportunities that have been ignored and viewpoints that have been reluctant to change. How many manufacturers have made a real study of the relation of log sizes to grades? How many have made a serious attempt to extend the life of their operations by less destructive logging or better utilization? How many have figured carefully on the possibility of spreading a ten year cut over twenty years and offsetting the higher overhead by eliminating losses on small, low grade logs? These are some of the contributions private owners can offer at this stage.

It is useless to talk about stabilizing an industry or protecting public interests, unless the solution starts with the component units of forest ownership. All the hope and promise and good intent will founder on the realities, or on the skepticism reflected from them, unless there is feasible business incentive to accept new responsibilities and adopt new methods.

Whether we like the word or not, the public contribution becomes in effect a subsidy, to cover the gap between what private initiative is able to do and what public interests require. The part of the responsibility or burden that private ownership cannot assume is fairly well recognized. Some of the tax burden must be assumed or carried forward by public agencies; the use of public credit is a

legitimate essential of long-time forest management; cooperative protective measures can be broadened and intensified; and government research and influence may well be directed in greater measure to the neglected factors of markets and distribution of forest products.

There will be a willingness to meet and solve the problems of private forest ownership on their merits, as long as the spirit of American democracy prevails. There will also be many good citizens who believe that the government has a big enough job in rendering aid and cooperation and in managing protection and reclamation forests, without tackling commercial timber production. The same citizens will also hold to the tenet that the best insurance for social security is to first safeguard the economic security of private property, whether farms, factories or forests.

As of the early months of 1937, with the stage apparently set for further business recovery, are there better opportunities for attaining the forestry objectives than have been outlined? The premises remain essentially the same, with perhaps the one advantage that industry, with improved markets, can better afford to do the things it would like to do and that government agencies insist it should do. Against this, in some regions, is the frankly expressed concern as to the end, aim, and effect of the government policy of timberland acquisition. Does it lead to the collectivism of a socialistic state, to mere top-heavy public ownership, or to the sound coordination and development of public and private land in working units, as proposed and widely endorsed?

Whatever the outcome, the burden has not been lightened or lifted from private ownership in any marked degree. The tax problem remains unsolved, the credit needed for long time management is still unavailable and the recourse of industry remains the ability to operate permanently and remain solvent, in the

case of many recognized handicaps. If private forest enterprise is to succeed, and at the same time meet the public responsibility it is charged with, it must do it largely on its own resourcefulness, aided or hindered, as the case may be, by political and economic influences beyond its control. It must shoulder, if prosperous, a heavy added burden of taxation, in common with other business, and it may find itself helping to pay for policies, as in land acquisition, that are helpful or otherwise, according to regions and ultimate developments.

The private worries are both industrial and individual. Upon analysis any given section or region resolves itself into units, of widely varying size, condition and ownership. Industrial unity or cohesion applies to only a very small percentage of timberland ownership; yet all have the common purpose of making their lands as productive of income or as potentially valuable as possible. The form of realization in the past has been mainly liquidation, for known reasons; while future yield of sustained value is what owners and public agencies would like to bring about.

Again, it comes back to how to do it and what has been lacking that it has not been done in greater measure. If the silvicultural and economic requirements cannot be coordinated there is small promise of forestry, as a business. If it is not profitable for private ownership, it is equally poor business for the public to go beyond the minimum needs for protection. Where essentials leave off and luxuries begin is anybody's guess, but there is a reasonable limit to spending as there is to negligence. Recreation forests and wilderness areas are fine, if we can afford them; more public forests are justified, if we really need them; but before going too far and forgetting that some one must pay—and how—it may be well to figure the cost in terms of use value and common sense. Commercial forests

can be profitably maintained only from what they produce; while protection or luxury forests that absorb wealth from other sources must be productive of essential public benefits, if the spending is not to become a liability.

With forestry getting the breaks for the past few years and making the front page on the more spectacular phases, there is also some encouragement for those who hold to the old-fashioned idea that better forest management needs a sound business foundation. All the preaching for thirty years brought little change in the operating procedure of stumpage conversion, for the very simple reason that the invested capital could not see and was not shown that any course other than liquidation was feasible. Foresters did not have any practical answer and only within the last decade has an approach to sustained yield by selective cutting been worked out and applied, even in a small way, as the forester's contribution to the business of forestry. Progress, except where the public pays, is marked by the slow process of making suitable forest lands self-supporting under continuous production and the time seems nearer when they will do that very thing.

Much of this, of course, is another story that unfolds as the wheels of progress roll along. Perhaps the most encouraging and tangible advance is the transformation in the southern pine belt, from a combination of favorable conditions that carry their own load. Anticipated and promoted by a few, the South suddenly found itself forest-minded, with a capacity for production and an economic incentive for better forest practice that go a long way toward building a better future. It was coming anyway, then almost overnight the pulp and paper

industry went South in a big way and provided the impetus to carry on from where "dual purpose" trees and the "liquid gold" of naval stores left off.

The investment of millions of dollars in new mills, that are dependent upon the renewable raw material of the southern pinelands, give an incentive for forest production and forestry practice that comes from stable values and competitive demand. The sound business confidence in the renewable resources of southern pine is in striking contrast with past dependence on liquidation of mature reserves of slower growing northern species. Not that an adequate present supply of southern pulpwood timber is lacking, but the general acceptance of permanence and stability from regrowth is new and good news for forestry. Nature, in fact, has been doing a pretty fine job unaided and with a little help will provide southern industries with wood in any form that has market value.

From the time man learned to barter, the world has been searched and dug and scratched to find something that could be sold or exchanged for money or some equivalent form of satisfaction. Since trees happen to have utility value they have been converted to human needs and the time element has been against their replacement. As the scarcity factor makes itself felt, the obvious job is to grow some more, and all that is needed is the incentive for doing it.

This will come when and to the extent that permanent wood consuming or producing enterprises find themselves dependent for raw material and financial success upon the practice of forestry. Large southern pulp and paper mills come closer to these specifications than any timber business has come before.

## COMMENTS

BY PERKINS COVILLE

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MR. STERLING'S article covers too complex a subject to permit comprehensive comments in the space allowed. I will confine my comments therefore to one or two phases.

Many units of the pulp and paper industry in the South undoubtedly have the best opportunity to practice forestry that can be found in this country. I do not think, however, as Mr. Sterling suggests, that they necessarily will practice forestry purely because raw material and financial success depend upon it.

Many of these plants represent large investments which have only been made after an analysis of total available raw materials. In spite of the large investment, in several instances little or none of the tributary timberland has been bought or leased. In such cases it appears that the plant management can at best only practice forestry, if any, by indirection, i.e., secure some forestry through its buying policy, stipulating the leaving of seed trees, not cutting trees below a given diameter, etc. This method, in so far as it has been tried, appears only moderately effective.

Probably none of the southern pulp plants has enough owned or controlled timberland to supply its full requirements (built and building) though one or two approach it closely. It has become apparent that some of the plants on the basis of current returns from manufacturing pulp and paper could liquidate their plant investment in from fifteen to twenty-five years. If there is adequate wood on the open market to supply a plant for that period, there may be no financial

condition *forcing* the practice of forestry by the plant management. In fact the ownership of forest lands at the end of such a liquidation period might be a liability.

So much for the pessimistic side.

There are several factors which may, and it is to be hoped will, bring about the development of a great deal of forest practice by the industry. One of these is competition. There is an adequate supply of wood and an adequate growth of wood usable for pulp in the South, but how much will be used for pulpwood will depend upon competitive demand both for pulpwood and for other uses, wood prices, and the relative availability of the wood to different utilization plants. Second, the industry sees the advantages of practicing forestry and there is reason to hope that the members will agree among themselves to certain desirable minimum practices. Lastly, the public is better informed and there is more information available on the resource than ever before with the result that public sentiment will probably bring pressure for better forest practices. There is evidence of this in those states that have passed or definitely considered state regulatory bills, and the possibility of federal regulation.

Whether there is to be regulation or not the public has a responsibility to educate the small forest owner on better practices. The southern pulp and paper industry, willing as it might be to practice forestry, will find it difficult to secure good forestry practices on land it does not own or control, but from which it secures wood, unless other wood-using

industries cooperate and the land-owner is shown that forest practices benefit him in the long run. Cooperation of the other industries is mentioned because it is doubtful if pulpwood can be grown profitably as the sole crop, except in rare instances.

The installed capacity of pulp and paper mills now built and building in

the South is 3,900,000 cords annually and the end of new construction is not yet. This amount of wood in cords end to end would encircle the eleven southern states as a unit. If this vast amount of drain as well as other existing drain is to be supplied on other than a liquidation basis, forest practices in the South cannot be put into effect too soon.

# A BOARD FOOT VOLUME TABLE FOR EASTERN RED CEDAR

By WILLIAM MAUGHAN

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Eastern red cedar is a valuable tree in the eastern United States. Little attention has been given it because it makes up a minor part of the stands in which it occurs, hence red cedar volume tables have not heretofore been available.

ABOUT a year ago a cubic volume table was prepared for eastern red cedar (*Juniperus virginiana* L.) in the Duke Forest, based on stem analyses from 107 trees and constructed by the logarithmic regression equation method.<sup>1</sup> This table was made because, so far as the writer was informed, no reliable volume tables were available for red cedar and the need for them was increasingly apparent. Although constructed particularly for use in the Duke Forest, it was believed that the table could be applied with a fair degree of reliability in most of the Middle Atlantic Piedmont and it was presented with the idea that it might be useful to other foresters, particularly in the absence of other tables.

During the past winter the original data have been supplemented by additional measurements and a second table, constructed from the combined data and showing volumes in board feet to a 4-inch top, is presented. (See Table 1). The need for such a table has long been felt because much of the red cedar marketed in this region is sold on a board foot basis and is usually measured according to a log scale supplied by the purchaser. No reliable table showing the board foot content of trees of different sizes has previously been available and consequently it has been difficult for the timber owner to estimate accurately the volume of cedar standing in his woodland.

The data for this table were obtained

by measuring on each tree, the diameter, outside bark, at breast height; total height; and the diameter, inside bark, at points every 4 feet above a 0.5 foot stump. These taper measurements were plotted and the length of the upper fractional section, to a 4.0 inch diameter limit, determined from the straight-line graph. Board foot volumes were computed for each 4-foot section by the International log rule formula for saws cutting a  $\frac{1}{8}$ -inch kerf. Volumes of fractional upper sections were computed as fractions of 4-foot sections, depending upon length. Of the 107 trees used in compiling the cubic volume table, 76 were large enough to have board foot contents, under the definition of a 4-inch diameter limit used in compiling this table, and measurements were obtained from 92 additional trees to make a total of 168 trees used as a basis for the table. These trees were selected from 41 different stands scattered over most of the soil types and all of the forest types in which red cedar occurs in the Duke Forest.

This table was also constructed by the logarithmic regression equation method and the regression equation is:  $\text{Logarithm (total board foot volume, inside bark: } -0.68) = 1.4749 \text{ logarithm (diameter breast high, outside bark, in inches } -4.2 \text{ inches)} + 1.1231 \text{ logarithm (total height in feet } -4.5 \text{ feet)} - 1.2734$ . The figure 0.68 is the volume of a bolt 4 feet long with a diameter of 4.0 inches and is a

<sup>1</sup>Maughan, William. A cubic volume table for eastern red cedar, Jour. For. 34:777-778. 1936.

constant used in all calculations. The 4.2 inches and 4.5 feet represent values that must be subtracted respectively from diameter breast high, outside bark, and from total height so that the regression equation will not be affected by the inconsistencies in volumes of small trees, as explained by Schumacher and Hall.<sup>2</sup>

If volumes for trees falling between the tabulated classes are desired, they can readily be obtained by solving the above equation. For example: to find the board foot volume, between a one-half foot stump and a 4-inch top, in a tree 12.5 inches in diameter at breast height and 63 feet in height:

$$\begin{aligned} &\text{Logarithm of } 12.5 - 4.2 \text{ (or } 8.3) = .91908 \\ &\text{Logarithm of } 63.0 - 4.5 \text{ (or } 58.5) = 1.76716 \\ \text{Log. (Vol.} - 0.68) &= 1.4749 \text{ (.91908) + 1.1231 (1.76716) } - 1.2734 \\ \text{Log. (Vol.} - 0.68) &= 1.35555 + 1.98470 - 1.2734 \\ \text{Log. (Vol.} - 0.68) &= 2.06685 \\ \text{Volume} &= 116.64 + 0.68 \\ \text{Volume} &= 117 \end{aligned}$$

The writer is indebted to F. X. Schumacher of the U. S. Forest Service for his advice on the statistical methods involved

in the construction of this table. Copies of the table are available and may be obtained upon request.

TABLE 1

BOARD FOOT VOLUME TABLE FOR EASTERN RED CEDAR (*Juniperus virginiana* L.)  
IN THE DUKE FOREST<sup>1</sup>

William Maughan

International— $\frac{1}{8}$  inch kerf

D.b.h. o.b. Inches	Total height of tree—feet											Number of trees
	25	30	35	40	45	50	55	60	65	70	75	
Volume in board feet (inside bark)												
5.0	1	1	1	1	1	1	1	1	—	—	—	7
6.0	4	5	7	8	9	10	11	12	13	—	—	24
7.0	8	10	12	14	16	18	21	23	25	—	—	29
8.0	12	15	18	22	25	28	32	35	39	43	—	20
9.0	17	21	26	30	35	40	45	50	55	60	—	18
10.0	—	28	34	40	46	53	59	65	72	79	—	12
11.0	—	35	43	50	58	66	74	83	91	99	108	19
12.0	—	43	52	61	71	81	91	101	111	122	132	12
13.0	—	—	62	73	85	97	108	120	133	145	157	10
14.0	—	—	72	86	99	113	127	141	155	170	184	9
15.0	—	—	83	99	114	130	146	163	179	196	213	6
16.0	—	—	—	113	130	148	167	185	204	223	242	2
17.0	—	—	—	127	147	167	188	209	230	252	273	—
18.0	—	—	—	—	164	187	210	233	257	281	305	—
19.0	—	—	—	—	182	207	233	259	285	311	338	—
20.0	—	—	—	—	—	228	256	285	314	343	372	—
No. trees	12	21	33	41	24	19	14	3	1	—	—	168

<sup>1</sup>Blocks indicate extent of basic data. Basis: 168 trees from 41 stands in the Duke Forest. Stump height, 0.5 foot; top diameter, inside bark, 4.0 inches. Volumes computed by formula for International log rule, for saws cutting  $\frac{1}{8}$  inch kerf. Table constructed from logarithmic regression equation:  $\text{Log. (Volume} - 0.68) = 1.4749 \text{ Log. (d.b.h.o.b. inches} - 4.2 \text{ inches)} + 1.1231$   $\text{Log. (total height feet} - 4.5 \text{ feet)} - 1.2734$ . Standard error of estimate =  $\pm 13.49$  per cent.

<sup>2</sup>Schumacher, F. X. and F. D. S. Hall. Logarithmic expression of timber-tree volume, Jour. Agr. Research 47:719-734. 1933.

# THE TECHNIQUE OF DUFF HYGROMETER CALIBRATION

By T. KACHIN AND H. T. GISBORNE

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The duff hygrometer devised by the Forest Products Laboratory is now widely used to measure the moisture content of the duff. Because of the fact that duff moisture content must be known accurately in order to evaluate fire danger, duff hygrometers must be carefully calibrated. The technique of calibrating these instruments requires care and considerable time. Users of duff hygrometers undoubtedly will be interested in knowing precisely how they are calibrated.

THE moisture content of the top layer of coniferous needles and twigs covering the forest floor is one of the factors of forest fire danger which must be determined accurately if fire danger in such timber types is to be measured. As this moisture content cannot be estimated accurately and as a difference of a few per cent of moisture, especially in the lower range, has been found<sup>1</sup> to cause significantly different inflammability, measurements rather than estimates are needed.

Duff moisture could be measured, of course, by the conventional collection and oven drying of samples. Such a practice, however, requires from 6 to 12 hours of time and the use of rather elaborate equipment before the duff moisture can be known. The xylol or some other chemical extractive method might be used to reduce the time, but expensive equipment and exceptional care are then even more essential if results are to be accurate. In addition, the results of both of these methods are subject to the error of sampling, because no two samples can be collected from the same spot having identical environments. The importance of this feature has been shown by recent work to be even greater than was originally thought.

For daily use at numerous field stations, where duff is a forest fire fuel of material significance, some instrumental method giving an immediate indication of duff moisture is necessary. To meet this need M. E. Dunlap of the U. S. Forest Products Laboratory, in 1923, invented an instrument called a duff hygrometer. The present model, No. 7, illustrated by Figure 1, is the result of many changes to improve the accuracy and to reduce the cost.<sup>2</sup> So far as is known this is the only instrumental method available for measuring duff moisture.

## THE INSTRUMENT

The duff hygrometer utilizes the principle of expansion and contraction of a hygroscopic material when exposed to different moisture conditions. The material used is rattan rather than human hair, which is the actuating element often employed in atmospheric hygrometers and hygrographs. Although a strip of rattan is less sensitive than hair it is much more durable and is less affected by snails, worms, and insects which frequently inhabit the duff.

The duff hygrometer is a metal instrument which holds a strip of rattan under tension in a 12-inch long ventilated spike

<sup>1</sup>Gisborne, H. T. Measuring forest fire danger in northern Idaho. U. S. Dept. Agr. Misc. Pub. 29. 1928.

<sup>2</sup>Descriptions of previous models have been published by Gisborne (loc. cit.), and by Stickel (loc. cit.).

so that changes in length of the rattan are shown by a pointer and scale enclosed in a fan-shaped housing attached to the spike. In actual use the spike is inserted horizontally in the duff, barely beneath the surface, so that as this layer changes moisture content the rattan changes with it, the position of the pointer indicating the duff moisture content. The instrument stays in the same spot throughout a season and may be reinserted season after season, readings being made as frequently as desired. So long as the instrument retains its calibration, or so long as replacements are accurately calibrated, the measurements are therefore fully comparable, with the error of sampling entirely eliminated.

#### CALIBRATION

*Necessity and Accuracy.*—As all strips of rattan do not respond alike to moisture each instrument must be calibrated. As the response also varies with age or exposure to the weather each instrument must be calibrated at least once each year. Experience has shown that an accuracy of  $\pm 0.5$  per cent duff moisture is possible for moisture contents below 12 per cent,  $\pm 1$  per cent from 12 per cent to 18 per cent,  $\pm 2$  per cent from 18 per cent to 25 per cent, and  $\pm 5$  per cent from 25 per cent to 35 per cent. The maximum duff moisture above which rattans fail to indicate changes varies from 35 per cent to 50 per cent with different rattans. As duff will not carry fire when it has more than 25 per cent<sup>3</sup> or 30 per cent moisture<sup>4</sup> this instrumental accuracy and range are satisfactory for field use in measuring fire danger.

*Choice of Method.*—At least two methods may be used for calibrating duff hy-

grometers. By the first method the instruments are exposed in duff of known moisture content, at various percentages between oven dry and 50 per cent, and the position of the needle marked on the dial for each known or interpolated moisture content. The second method is based upon the fact that duff moisture is known when in equilibrium with any combination of air temperature and humidity such as naturally occurs under free air or forest conditions. Duff hygrometers therefore may be subjected in air conditioned chambers to representative combinations of temperature and humidity, and the dial then calibrated directly in terms of duff moisture.

As air conditioned chambers, maintaining satisfactorily constant conditions at any desired point throughout the range of temperature and humidity are not generally available, and as their cost is high this second method is seldom used.

*Material and Equipment.*—Calibration by exposure in duff of known moisture content requires the following equipment:

Electric oven, at least 16 inches deep by 24 inches wide and 18 inches high, inside dimensions.

Scales or balances of 1000-gram capacity, and a sensitivity of one-tenth gram at near maximum load.

About 2.5 kilograms of recently collected, top layer duff of the type in which the instruments are to be used.

Fifteen duff containers, to be described.  
Six dozen No. 3 rubber stoppers.

Forms for recording the data, cross-section paper, India ink, and an ounce of shellac.

The duff containers or calibration tubes may be made in various forms. At the Northern Rocky Mountain Forest and Range Experiment Station they are made

<sup>3</sup>Gisborne, H. T. Measuring fire weather and forest inflammability. U. S. Dept. Agr. Circ. 98. 1936.

<sup>4</sup>Stickel, P. W. The measurement and interpretation of forest fire-weather in the western Adirondacks. N. Y. State Coll. of For. Tech. Pub. 34. 1931.

from 18- or 20-gage galvanized iron. The tubes are about 15 inches long by 4 to 5 inches in diameter, with one end crimped and soldered air tight and the other end closed by a friction cap fitting as tightly as possible, yet being removable. The sides of the cap should overlap the sides of the tube about 3 inches. Such a can will hold from 125 to 150 grams of oven dry duff without packing.

Two holes are bored in the end and in the cap of each container, of a size to be closed by a No. 3 stopper. Each tube is numbered or lettered on one side and on the cap. The containers are then oven dried at 100° C., removed from the oven and allowed to cool to room temperature, and the empty, dry weight determined and recorded. As the accuracy of calibration of hygrometers will be no greater than one half of one per cent, and as the duff sample will weigh at least 100 grams, the tube and contents may be weighed to the nearest 0.5 gram. However, as most laboratory scales that might be used for this work are as easily read to the nearest 0.1 gram this degree of precision is recommended.

For each duff hygrometer to be calibrated at least one rubber stopper is bored so that the spike of the hygrometer can be inserted through it and fit snugly. The remaining stoppers are used in solid form to close the duff tube holes not being used by hygrometers. The stoppers need not be weighed because the tubes, empty or full of duff, should always be weighed without stoppers.

A calibration record form found helpful in this work consists of a single sheet for each duff hygrometer with a main heading: "Instrument No. ...." Five column headings include: "1 Date, 2 Calibration tube No., 3 Weight of tube plus duff plus moisture, 4 Moisture content in per cent, and 5 Instrument scale reading."

*Preparation of Duff Samples.*—At least

two methods of preparing duff samples are possible. By the first method the entire duff supply is brought to a uniform condition by sealing it in a container and shaking this frequently to mix the duff. After three or four days of such conditioning, samples are withdrawn, weighed, oven dried, and the moisture content determined. The average moisture content of these samples is assumed to be that of the main duff supply, and the duff tubes may then be filled from this supply, weighed, and the oven dry weight of the contained duff computed.

Although this method obviates oven drying the duff used in the tubes, and thereby avoids the possibility of affecting the natural hygroscopicity of the material, it has not been found as accurate and dependable as the second method.

By the second method the entire supply of duff to be used in the tubes is oven dried in open pans, by the following schedule: about 24 hours at 75°, 24 hours at 85°, 24 hours at 95°, and 12 hours at 100° C. The empty duff tubes are inserted in the oven for the last 15 minutes of this schedule and are then filled to capacity, but without forcible packing. The friction tops to the cans are put on and the filled cans are left in the oven at 100° for a few hours more to remove all moisture. After this drying the containers are quickly weighed. Speed and a warm, dry room are essential to prevent absorption of moisture. By subtracting the dry weight of the container, when empty, from the dry weight when full, the oven dry weight of the duff sample is determined.

Tubes numbered 1 to 11 are then arranged in order and water is added to the duff to bring the samples, respectively to the following moisture contents: 2, 6, 8, 10, 12, 15, 19, 25, 35, and 50 per cent. Less tubes and consequently fewer known moisture contents could be used but experience with the above number are

distribution of samples has been found well worth while. No water is added to the duff in tubes 12 to 15 until they are needed either as a check on one of the other samples or as a test for some intermediate moisture content. The holes in all tubes are then closed tightly with the solid rubber stoppers until the added moisture has diffused evenly throughout the duff sample.

The diffusion of moisture can be has-

tened, first by adding it by burette through each of the four holes, and second by returning the stoppered tubes to the oven, set at about 50° C., for an hour or two. After removal from the oven an additional 24 to 48 hours should be allowed for complete diffusion and absorption.

After such preparation the stoppers are removed from each tube and it is weighed as a final check of the moisture content of each sample. This checking may re-

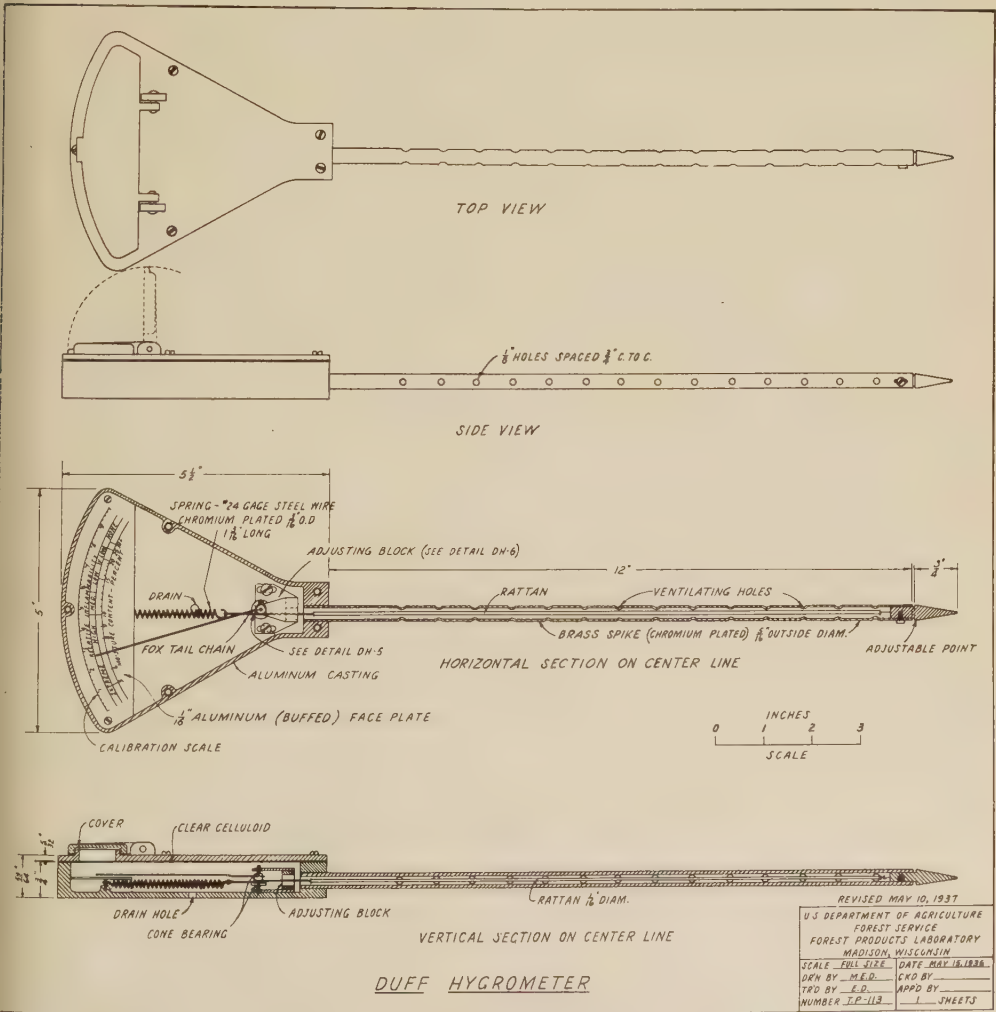


Fig. 1.—Top and side views of a duff hygrometer showing important features involved in its calibration.

veal the need for adding moisture in some tubes, or the removal of moisture from some by further oven drying. It is not necessary, of course, to have exactly 10.00 per cent moisture in the 10 per cent tube; from 9.5 per cent to 10.5 per cent serves the purpose perfectly well. The moisture content should be computed, however, to an accuracy of one tenth of one per cent.

While the duff tubes are being prepared old hygrometers should be cleaned and all instruments should be limbered up by subjecting them alternately to high and low moisture conditions. One purpose of this limbering process is to detect instruments lacking in spring tension, off the scale at one end or the other, having exceptionally sluggish rattans, or otherwise defective. This limbering up also is necessary in order to remove a "set" condition of the rattan which seems to result from storage under constant conditions. By wrapping the spikes in wet paper or cloth for 4 to 6 hours, then exposing the instruments to dry air in a room, or even an oven at about 38° C for a few hours, and repeating these processes two or three times, the rattans become much more susceptible to accurate calibration. As an alternative method the instruments may be inserted first for a few hours in the 50 per cent test tube and then the 6 per cent or 8 per cent tube. This practice is not recommended, however, because of the possibility of removing and losing a small amount of duff with each extraction of the spike. Although the loss of such a small weight from a 150 gram sample is not material if it occurs only once or twice, several repetitions may result in an appreciable error.

After all tubes have been brought to the desired moisture contents, and the duff hygrometers have been limbered up, the instruments are inserted, using the bored stoppers. A beginning may be made in any tube but the labor will be reduced by filling each tube with four instruments rather than scattering them among several

tubes. After insertion in the first tube the instruments should be left at least 12 hours before the dials are read. Each dial should be tapped gently until the needle comes to rest, then the reading is made.

*Scale Calibration.*—At the outer edge of each duff hygrometer dial a scale of ten units, each unit subdivided into five equal parts, has been marked by the manufacturer or by the Forest Products Laboratory. This is indicated in Figure 1, as the "calibration scale." This scale is used in the original calibration and in each recalibration. Its purpose is merely to control the distribution of duff moisture per cent graduations, which make it possible to determine duff moisture directly from the instrument without use of a chart. A chart of the type shown by Figure 2 must be made, however, for each instrument before the duff moisture graduations can be linked on the hygrometer dial.

After an instrument has been in a duff tube for a sufficient period the dial is tapped, the reading on the outermost of the calibration scale is made and recorded on the calibration record form, the weight of tube and contents is determined and recorded, and the duff moisture content computed and recorded. Separate, straight line ratio charts showing the duff moisture content for any total weight of tube, duff and moisture are an aid in reducing the time and preventing errors in this last computation.

With these data recorded and checked the duff hygrometer is then inserted in the tube of next higher or lower moisture content. If the movement is to a tube not more than 5 per cent greater or less in moisture than the last, the rattan can be expected to reach approximate equilibrium within a maximum of 6 to 8 hours, when new readings may be made. The length of this recommended period does not indicate that rattans are sluggish in response to changed moisture. As a test will show an instrument registering say 8 per cent duff moisture will commence to respond

within 30 seconds to the normal moisture of a person's hands grasping the spike. However, final equilibrium with the last one half of one per cent of moisture requires several hours.

The last expansion or contraction of a rattan approaching equilibrium with duff of a certain moisture content is so slow that even when an instrument is left in a tube for 6 to 8 hours the reading reached after movement from the 8 per cent to the 10 per cent tube will not be exactly the same as when the movement has been from the 12 per cent to the 10 per cent tube. This lag is a well known phenomenon called hysteresis. Its effects can be eliminated either by leaving the hygrometers in each tube for 48 hours or more, or by obtaining both increasing and decreasing readings, first, with the rattan expanding toward equilibrium, and second with the rattan drying and contracting. The average of these two readings is then accepted

as most accurate. It is essential that a duff hygrometer calibration curve, like Figure 2, should include readings obtained with the instrument moved progressively from low to high duff moistures *and* with the instrument moved progressively from high to low moistures.

After scale readings have been obtained at all duff moistures included by the tubes these data are plotted on coordinate paper, and a smooth curve of best fit drawn as in Figure 2. A tabulation is then made showing the scale reading corresponding to duff moisture contents of 1 to 20 per cent, respectively, by single per cents, and for 25, 30, 35, and 50 per cent. From these data the instrument dial can be graduated so that the position of the needle pointer may be read directly in terms of duff moisture content.

*Graduating the Dial.*—The face plate, shown in Figure 1 on which the dial is graduated should be removed from the

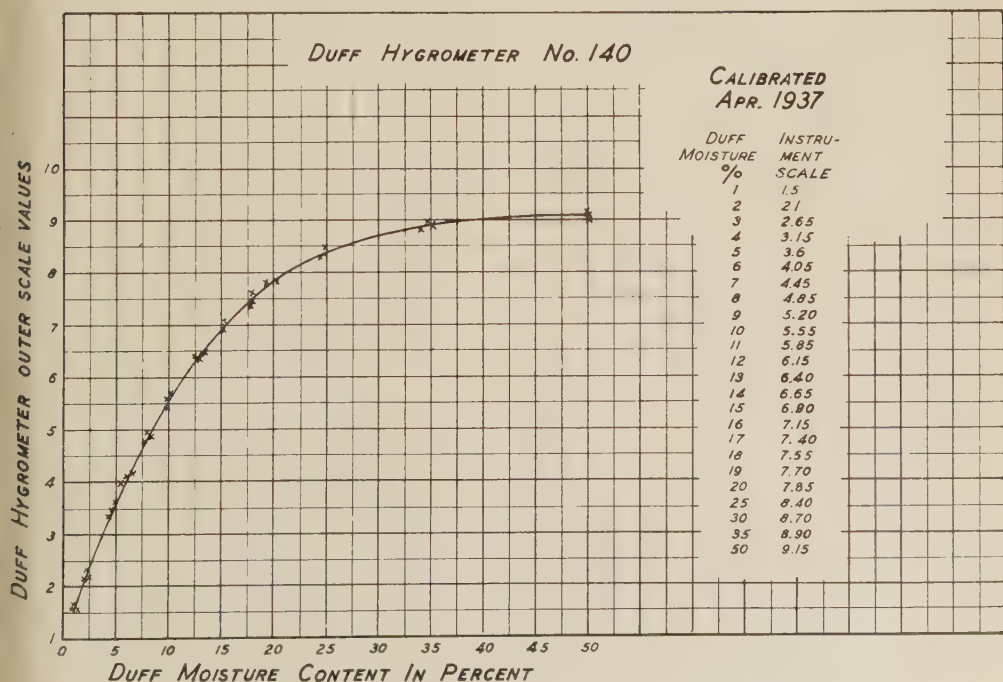


Fig. 2.—A duff hygrometer calibration curve.

instrument before attempting to mark new graduations on it. This must be done with care not to force the pointer to the right. The pointer may be moved to the left, toward lower moisture contents, without danger, however. The face plate should then be screwed or tacked firmly to a board, about 6 by 8 inches for cleaning and graduating.

A small cloth moistened with alcohol should be used to clean the face plate and to remove former duff moisture scales no longer accurate. Care should be exercised, however, not to remove the calibration scale at the extreme outer edge of the plate. After the plate has dried it is given a light coat of shellac. When that is dry the plate is rubbed lightly with talcum or tracing cloth powder.

Using the outer arc, along which the calibration scale of 1 to 10 is graduated, the center of this circle is found and two new concentric arcs are drawn on the face plate. The first should be drawn with a radius about  $\frac{3}{8}$  inch less than the outer scale arc. The second should have a radius  $\frac{5}{8}$  inch less than the outermost. This provides the space within which the duff moisture graduations are inked, each graduation being carefully drawn from the circle center to the exact calibration scale tabulated from the chart similar to Figure 2. Below the innermost arc the caption "Moisture content in per cent" is then lettered, as shown in Figure 1. The six classes of relative inflammability may or may not be inscribed, as desired. A last coat of shellac is given to the dial face after all ink is dry.

*Final Calibration Check.*—After the dial has been graduated the instrument should be checked in at least two and preferably four tubes. Checks at 4, 10, 20, and 35 per cent are recommended, first to determine whether the instrument has been thrown out of adjustment by the work on the face plate, and second to detect serious errors in graduating the plate. In these

checks the instrument will be expected to read a fraction of a per cent low when inserted in a can of higher moisture, and a fraction of a per cent too high when moved from a moist to a drier calibration tube. However, discrepancies exceeding the limits of error originally established as permissible should be investigated.

*Shipment and Field Checks.*—As a duff hygrometer has its rattan held constantly under tension by means of wire wrapping and ties at each end of the rattan, and as these ties are held elsewhere by the adjustable spike tip or the movable needle mounting, hard jars or jolts are likely to impair the calibration. Consequently all instruments should be packed in resilient material and then securely boxed for shipment to field stations.

Upon receipt of an instrument at a field station, it should be tested by the wet towel method to determine whether or not its calibration has been injured in transit. A towel is thoroughly saturated with water, wrung only slightly, then wrapped around the instrument spike to cover it entirely. After such exposure for about 12 hours the pointer should come to rest at the highest, or 50 per cent, duff moisture graduation when the dial is tapped. If it does not do this, even after another 12 hours in a resoaked towel, the screw holding the adjustable spike tip should be loosened, without otherwise exposing the spike to dry air, and the tip moved until the needle pointer indicates the maximum duff moisture shown on the dial. If the spike tip has not sufficient movement for this, the sliding block holding the needle mounting inside the housing should be adjusted. Between these two adjustments there is almost always sufficient movement to reset the instrument. If a rattan tie wire has broken, however, the instrument will have to be returned to the calibrating laboratory for repair.

Tests of instrumental accuracy can be made during the field season only by the loss of one or two daily measurements, unless extra instruments are available. If the accuracy is doubted, however, the instrument can be removed from the duff and be given the wet towel test, adjustment being made if the needle pointer fails to indicate the maximum duff moisture graduated on the dial. Such adjustment may, however, introduce error in the lower moisture contents if it is made after more than four months' daily exposure of the instrument because by that time the rattan will have permanently stretched a few thousandths of an inch and the pointer can be expected to indicate slightly more than the maximum duff moisture shown by the original calibration. After such a test care should be exercised to insert

the instrument spike at the same depth below the duff surface, and to compact this duff around the spike as it was before the instrument was removed.

Probably the best method of checking a duff hygrometer in field use, if its accuracy is seriously doubted, is to call on the regional calibrating laboratory for a new instrument, returning the old one for calibration tube test after the new one is received.

#### CONCLUSION

Although the technique of duff hygrometer calibration is rather time consuming and requires exceptional care, this instrument provides the only method at present available for quick and reasonably accurate measurements of duff moisture content unaffected by the large error of conventional sampling.

# ECONOMIC RESEARCH AND FOREST PLANNING

By H. R. JOSEPHSON

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Forest-use planning is a complex rather than a simple problem. Although the desirability of sustained-yield management is generally recognized it does not necessarily follow that sustained-yield timber production should be practiced on all timberlands because of the probable future demands for lumber. Furthermore, management of forests frequently will be profoundly affected by factors entirely beyond the control and unpredictable by the manager. Some of more obvious of these factors are taxation and tariff policies.

**F**OREST-USE planning is possible only in relation to the marketing or use of the products and services provided by forest lands. Since forest planning is aimed mainly at future use, research must discover and evaluate the economic trends which in large measure will affect future utilization of forest lands and products. Studies of the factors which determine markets and population needs reduce the errors of estimates in planning and provide a better basis for administrative judgment.

One of the principal goals of forest planning is sustained-yield management of timberlands. While sustained production of forest products is strongly advocated, is there adequate evidence to show that such use will be economically possible? Although sustained use of all forest resources is indisputably desirable, it is possible that timber production as a primary goal of management should not be attempted on all forest lands but restricted to the best sites, with areas determined by probable markets.

Studies of lumber consumption in the United States show that lumber use dropped from 46 billion board feet in 1907 to 23 billion feet in 1930, and amounted to only 15 billion feet in 1934, in spite of a constantly growing population. More than temporary factors have caused much of this decline: the substitution of reinforced concrete and corrugated iron for wood; near completion of the Nation's physical plant, such as resi-

dences, farms, and factories; preservative treatment and better use of lumber; the mechanization of agriculture; and the declining rate of population increase. Per capita consumption of wood will undoubtedly stabilize, however, as it has in older countries, and the probable size of population in the United States gives a clue to possible future markets. The best estimates place the probable population at about 145 million people to be reached within 25 years. Without further population increases, lumber may then be used mainly for replacement, unless research develops new uses for wood.

Population changes will not only affect wood markets, but will influence local forest planning as well. In California, for example, a large increase in population will affect local lumber markets, and may increase markedly the use of forests and mountain areas for recreation or watersheds. Plans for fire protection, water development, and recreation, as well as timber production, must be drawn up with a view to future populations. Estimates indicate that California may have a total population of 10 million by the end of the century. With such an increase of about 4 million people, it has been estimated on the basis of trends in consumption that lumber needs in California will average around 2 billion feet a year, compared to about 3 1/3 billion feet during the boom years of the "twenties".

Planning must consider that about 40

per cent of the California lumber consumption during the "twenties" went into abnormal urban construction. Only about 10 per cent of the total was used for farm construction, while 22 per cent was remanufactured into box shooks. Future requirements will involve fewer new homes and construction and more building replacements, and will be affected by the continued use of wooden boxes and by industrial activity in California. Markets for specialty woods are affected by such trends as the decreased use of finish lumber and increased plaster-reveal construction.

Under conditions similar to those of the past, California will supply less than 1 billion feet in local markets, making additional lumber production dependent on eastern markets and on competition with other regions, such as the South. Forest planners cannot overlook research on the economic trends which partially determine the need for forest products and the type and intensity of management.

Even with reasonable estimates established for future markets, other studies are needed to show how sustained yield may be realized under existing conditions. Detailed studies of the relative costs and values in tree and log selection have showed the zero-margin trees on typical operations, and have helped to indicate the financial justification for sustained yield. The financial details of sustained management, however, are frequently uncertain. Heavy carrying charges constitute an obstacle which probably may be reduced through public credit and insurance. The working out of sound plans for forest credits and insurance depends to a large degree on research.

In addition, faulty administration of the property tax is usually a deterrent to private forest planning, tending to discourage sustained yield and place a premium on rapid depletion. Research

may not only indicate how tax administration may be improved by centralized and scientific assessment, for example, but also work out the technique for valuing sustained yield properties so that taxes will be equitable from all points of view. Results of research, such as the cover type map, can be of direct assistance to assessors and thus favor better tax administration. Both private and public studies designed to work out more efficient organization of the forest industries will also make possible better forest planning.

In the field of land-use planning, research in the biological phases of forest use is important, but the emphasis again is on people and their use of goods and services. Plans for land use must rest not only on studies of physical resources and their utilization, but also consider the type of people involved, their needs, and reactions to planned conditions.

Land-use planning involves more than forest use, for the purpose of such planning is to show the combination of uses for land areas that will yield the maximum amount of monetary and intangible social returns. Research studies provide a basis for economic classification of lands, usually between crop agriculture, grazing, timber production, or recreation. In parts of the Sierras grazing and timber use, for example, are alternative, and decision as to the better use rests upon analyses of relative costs and returns which show in dollars and cents what may be expected of each use. Long-time trends in demands for livestock and lumber must be analyzed, however, to judge future needs and returns for each product. Classification will also depend on a number of additional factors, including the vested interests of present users, the amount of employment provided, and the intangible returns from community stabilization. In each case there is to be considered the effects of planning on the individuals, groups, and government involved, as well

as all major factors which will make plans succeed or fail.

Forest planning may frequently be part of a larger plan or policy, such as a national policy of decentralization of industry and population. Forest work under such a plan may provide supplementary or even full-time employment which, in combination with agriculture or manufacturing, will insure stable community incomes. Forest planning in such cases cannot be dissociated from research that includes all resources and all uses in the planning area.

Management of forests frequently will be modified or controlled by major economic policies and trends affecting the entire nation. Tariff policies, for example, influence the location of lumber and paper industries, and by their uncertainty make forest planning in a country of high tariffs subject to the hazards of political changes. Forest planning must consider that tariffs may tend to favor

and perpetuate uneconomic or high-cost industries which may collapse with the removal of tariff protection. Taxation policies also influence the attractiveness of private forest planning, for when forest taxes become more predictable, management will become more certain. Since major policies beyond the control of foresters and lumbermen may easily upset independent plans, and decree such policies as regulation of industries or prices and production control, study of indirect but determinate trends in policies is essential.

These examples perhaps indicate the use of economic studies in relation to planning. Without more research, forest planning will continue, and timber will be grown and used. Research can be of material assistance to planning, however, by analyzing the economic trends upon which planning is based, and by showing the combination of uses which will realize the highest monetary and social returns from the use of forest resources.

# ROOT STUDIES OF IMPORTANT RANGE PLANTS OF THE BOISE RIVER WATERSHED

By LITER E. SPENCE<sup>1</sup>

*Soil Conservation Service*

A serious range-erosion situation has developed on the Boise River watershed in southwestern Idaho. An intensive study of this problem reveals the fact that the erosion is largely the result of the replacement of fibrous-rooted plants by those having taproots and semitaproots, and that it can be controlled effectively by reestablishing the original grass species or similar fibrous-rooted plants.

RECOGNITION of excessive erosion of western range lands as a serious threat to the continued economic and social development of the intermountain valleys has given rise to studies by ecologists and conservationists aimed at determining the role played by vegetative cover in regulating run-off and maintaining the soil on steep mountain slopes.

Investigations by Bailey (1), Forsling (2), Meginnis (3), Renner (5), and others indicate that the character and density of the plant cover have a profound influence on the rates of run-off and erosion under widely different conditions of soil and climate. Pearse and Woolley (4) measured the increase in the rate of absorption of surface water by soils due to the presence of vegetation, and showed that fibrous-rooted plants are much more effective in promoting absorption than are taprooted species. Weaver and Kramer (8), after a study with cultivated crops and native vegetation in Nebraska, pointed out that plant roots played an important part in protecting soil from washing away, and that species vary greatly in their effectiveness in this respect.

The physical characteristics of the root system of western range plants, however, had not been closely investigated prior to this study. The critical condition of many watersheds in the West definitely

points to the need for information regarding the pattern and extensiveness of root systems of range plants before an effective plan of rehabilitation can be launched on areas where the vegetation has been depleted by overgrazing, fire, and subsequent erosion. Accordingly, a study, designed to supply a portion of this needed information, was made during the summers of 1933 and 1934 under the direction of the Intermountain Forest and Range Experiment Station.

## LOCATION AND METHODS OF STUDY

Because of the serious range-erosion situation which has developed on the Boise River watershed in southwestern Idaho, this area was chosen for study. Excessive erosion and flashy spring run-off from this watershed are threatening the security of large investments on the 350,000 acres of irrigated land in fertile Boise Valley. A survey by the Forest Service indicated that range depletion and accelerated erosion are most serious on the lower elevations of this 1,700,000-acre watershed, and for this reason the root studies were concentrated largely on the spring and early summer ranges varying in elevation from 4,000 feet to 5,000 feet. In addition, two areas were examined in the summer range type at an elevation of 7,800 feet. The distinguishing features of the nine study areas are presented in Table 1.

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TABLE 1

## CHARACTERISTICS OF STUDY AREAS

## I. Early Spring Range, Approximately 4,000 Feet Elevation.

## 1. Wood Creek area

Slope: 48 per cent; south exposure.

Soil: Loose, coarse granite, low in humus.

Vegetation:

Estimated density: 20 per cent.

Dominants: *Bromus tectorum*, *Madia glomerata*, *Amsinckia rugosa*, *Lactuca scariola integrata*, *Gayophytum diffusum*, *Agoseris heterophylla*, *Phacelia heterophylla*.

## 2. Cow Creek area, south

Slope: 26 per cent; south exposure.

Soil: Loose coarse granite with a fair amount of humus.

Vegetation:

Estimated density: 11 per cent.

Dominants: *Artemisia tridentata*, *Bromus tectorum*, *Poa secunda*, *Astragalus mortoni*.

## 3. Cow Creek area, north

Slope: 72 per cent; north exposure.

Soil: Basically the same as Cow Creek area, south, but contains more humus.

Vegetation:

Estimated density: 30 per cent.

Dominants: *Artemisia tridentata*, *Festuca idahoensis*, *Agropyron inerme*, *Koeleria cristata*.

## II. Early Summer Range, Approximately 4,500 Feet Elevation.

## 1. Lester Creek area

Slope: 50 per cent; south exposure.

Soil: Loose coarse granitic, very shallow, practically no humus.

Vegetation:

Estimated density: 18 per cent.

Dominants: *Hydrophyllum occidentale*, *Leptotaenia multifida*, *Balsamorhiza sagittata*, *Prunus melanocarpa*, *Odostemon repens*, *Purshia tridentata*.

## 2. Long Gulch area, south

Slope: 45 per cent; south exposure.

Soil: Loose coarse granite, very little humus present.

Vegetation:

Estimated density: 12 per cent.

Dominants: *Bromus tectorum*, *Lactuca scariola integrata*, *Collomia linearis*, *Gayophytum diffusum*, *Phacelia heterophylla*, *Balsamorhiza sagittata*, *Chaenactis douglasii*, *Eriogonum umbellatum*, *Artemisia tridentata*, *Purshia tridentata*, *Prunus melanocarpa*.

## 3. Long Gulch area, north

Slope: 67 per cent; north exposure.

Soil: Basically the same as Long Gulch area, south, but contains an abundance of humus.

Vegetation:

Estimated density: 43 per cent.

Dominants: *Carex geyerii*, *Eriogonum heracleoides*, *Hieracium scouleri*, *Balsamorhiza sagittata*, *Achillea lanulosa*, *Lithospermum ruderales*, *Lupinus ornatus*, *Phlox longifolia*, *Potentilla blaschkeana*, *Pentstemon glaber*, *Agropyron inerme*, *Festuca idahoensis*.

## 4. Elk Creek area

Slope: 37 per cent; southwest exposure.

Soil: Granitic clay soil, light in color with only a thin layer of humus.

Vegetation:

Estimated density: 22 per cent.

Dominants: *Bromus tectorum*, *Gayophytum diffusum*, *Balsamorhiza sagittata*, *Poa secunda*, *Agropyron inerme*, *Astragalus mortoni*, *Eriophyllum integrifolium*, *Achillea lanulosa*.

## III. Late Summer Range, Approximately 7,800 Feet Elevation.

## 1. Fall Creek area

Slope: 36 per cent; south.

Soil: Glacial drift of granitic origin, fairly rich in humus.

Vegetation:

Estimated density: 32 per cent.

Dominants: *Aconogonum phytolaccaefolium*, *Lupinus comatus*, *Stipa columbiana*, *Melica bella*, *Sitanion hystrix*, *Agropyron inerme*.

## 2. Trinity Ridge area

Slope: 45 per cent; east exposure.

Soil: Loose coarse granite, low in humus.

Vegetation:

Estimated density: 18 per cent.

Dominants: *Stipa lettermani*, *Lupinus tenellus*, *Spraguea nuda*, *Sitanion hystrix*.

The root systems of from three to five individuals of each species, as well as communities made up of several species, were studied on each area. The same species were excavated on north and south aspects where they so occurred within elevational zones, and those occurring over a wide elevational range were studied on two or more areas.

The procedure in excavating the roots was similar to that described by Weaver (7) except for variations necessary to meet the conditions of the area. When a group of plants had been located for study, the operator dug a trench with a shovel along the contour of the slope about 15 cm down the hill from the plants. The trench was made wide enough for a man to work in and as deep as the deepest roots to be excavated. An ice pick was then used to work away the soil and expose the roots which were drawn to scale on coordinate paper. The excavation was extended for a distance of 15 cm beyond the crown of the plant, thus providing a soil mass 30 cm in thickness for study purposes. Because of the great number of roots of the grasses, which if drawn would form an unintelligible mass, only about 25 per cent are shown in the sketches herein presented.

## SPECIES VARIATION

Detailed study of the drawings revealed that each species has a definite root pat-

tern from which individual specimens deviate but little. To be sure, individuals growing on north and east aspects tend to develop a more compact and shallower root system than do plants of the same species on south and west aspects. This tendency is most marked among the annual forbs, such as *Gayophytum diffusum*, but even in this case the difference is quantitative rather than qualitative. Individuals of the same or of closely related species, growing at different elevations, likewise were found to develop similar root systems, thus indicating that typical root systems could be selected for detailed study from specimens excavated at random, irrespective of aspect and elevation.

## CLASSIFICATION OF PATTERNS

When considered as a single group, the patterns of the root system of the 50 species excavated formed a fairly continuous series from the simple taproot of some of the annual herbs to the profusion of fibrous roots of *Carex geyerii*, with numerous gradations between these two extremes. Within this range of patterns, however, it was possible to segregate the root systems into four rather distinct classes (Figure 1). These are described in detail.

*Fibrous Root Systems.*—This class includes those species having a concentration of fibrous roots in the upper 3 cm

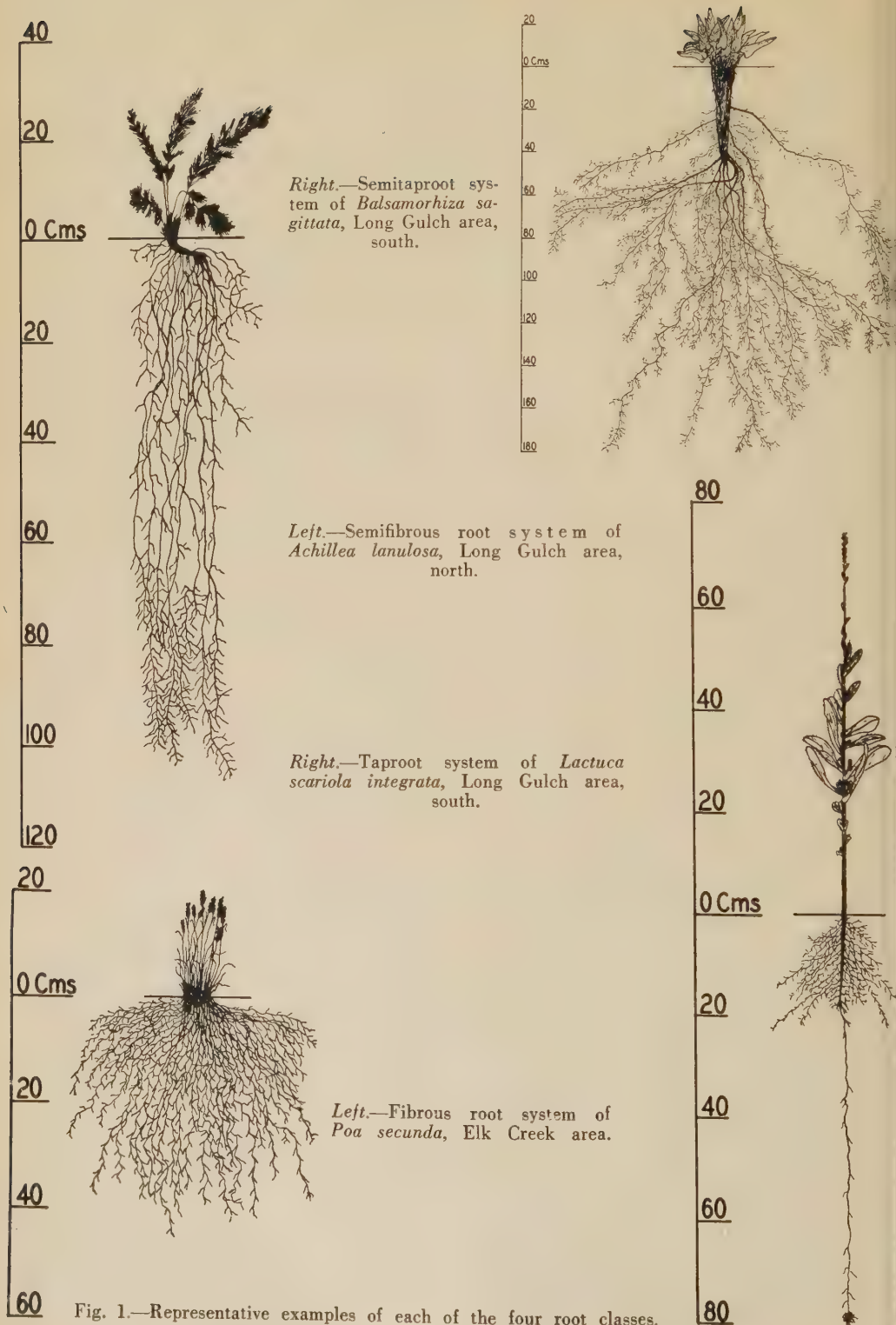


Fig. 1.—Representative examples of each of the four root classes.

of soil from which they spread laterally and downward, rather completely penetrating the upper 20 to 40 cm of surface soil. Eleven species were classified in this group as follows:

## ANNUALS

*Bromus tectorum*

## PERENNIALS

*Agropyron inerme*  
*Bromus marginatus*  
*Carex geyerii*  
*Festuca idahoensis*  
*Koeleria cristata*  
*Melica bella*  
*Poa secunda*  
*Sitanion hystrix*  
*Stipa columbiana*  
*Stipa lettermani*

The root systems in this class were found to differ in size and number of roots, direction of greatest concentration or spread, and depth of penetration. The average number of roots per plant and depth of penetration for the more common species included in this class are shown in Table 2.

Longevity and size of the aerial parts seem to exert considerable influence on both number of roots and depth of penetration per plant for the species included in this class. For example, annual grass plants such as *Bromus tectorum* have only about seven roots which penetrate the soil to a depth of 30 cm, while shortlived perennial grasses such as *Poa secunda* produce considerably more roots but penetrate only the upper 40 cm of soil;

whereas, the longer lived perennial plants studied develop more than 200 roots which, in most cases, extend to a depth of 160 cms. Of the latter group the root systems of *Agropyron inerme* and *Carex geyerii* are typical. The number of roots developed per plant by all members of this class is exceedingly great. Even small plants, no larger than one centimeter in area, were found to have as many as 75 roots, thus indicating that roots of closely spaced small plants may occupy the surface soil as completely as do those of larger plants.

**Semifibrous Root System.**—This class includes species having a short, horizontal, tuberous root 1 to 8 cm long from which 5 to 50 lateral roots spread 40 to 60 cm horizontally and from 40 to 190 cm downward. Vegetative propagation resulting in numerous horizontal subsurface roots and rhizomes is characteristic of most of these species. Five species were classified in this group as follows:

## PERENNIALS

*Achillea lanulosa*  
*Aster* spp.  
*Hieracium scouleri*  
*Pentstemon glabra*  
*Vicia americana*

The pattern of the semifibrous root system is very similar to that of the fibrous roots, but individual roots of the former group were found to be, in general, larger in diameter and fewer in number.

No appreciable amount of variation in the number of roots per plant between species within this class was observed. The depth of penetration, however, varies somewhat from one species to another. *Pentstemon glabra* and *Hieracium scouleri* commonly penetrate the soil to depths of 160 and 190 cm, respectively; whereas, the roots of *Achillea lanulosa*, *Aster* spp., and *Vicia americana* do not commonly extend deeper than 140 cm.

**Semitaproot Systems.**—This class includes a wide range of root patterns, vary-

TABLE 2  
FIBROUS ROOT SYSTEMS

Species	Average number of roots per plant	Average depth of penetration in cm
<i>Agropyron inerme</i> .....	176	105
<i>Carex geyerii</i> .....	259	160
<i>Festuca idahoensis</i> ....	201	40
<i>Poa secunda</i> .....	137	35
<i>Stipa lettermani</i> .....	56	80
<i>Bromus tectorum</i> .....	7	30

ing from somewhat tuberous to fairly fibrous types. A typical semitaproot system begins with a taproot which penetrates the soil from 50 to 80 cm before terminating in secondary leaders. In this branching zone numerous leaders are developed which give rise to an extensive, though irregular, network of laterals spreading in all directions. Because of this growth habit, roots of plants in this group tend to be more extensive in the lower than in the upper soil horizons. The following species were grouped in this class:

## PERENNIALS

*Aconogonum phytolaccaefolium*  
*Astragalus mortoni*  
*Astragalus purshii*  
*Amelanchier alnifolia*  
*Balsamorhiza sagittata*  
*Clematis hirsutissima*  
*Eriogonum umbellatum*  
*Eriogonum heracleoides*  
*Heuchera* spp.  
*Lappula floribunda*  
*Lithospermum ruderales*  
*Lupinus comatus*  
*Lupinus ornatus*  
*Lupinus tenellus*  
*Paeonia brownii*  
*Phlox longifolia*  
*Potentilla blaschkeana*  
*Prunus melancarpa*  
*Wyethia amplexicaulis*

Shallow as well as deep-rooted species occur within the semitaproot class. For example, the roots of *Phlox longifolia* and *Potentilla blaschkeana* penetrate only to a depth of 50 to 75 cm, which is no greater than the depth penetrated by annual forbs; while *Eriogonum heracleoides*, *Lupinus* spp., *Balsamorhiza sagittata*, and *Lithospermum ruderales* were found to penetrate to depths of 235, 240, 270, and 300 cm, respectively. Intermediate between these two extremes are such plants as *Clematis hirsutissima*, *Lappula floribunda*, and *Astragalus purshii* which de-

velop roots 100 to 140 cm in length.

*Taproot System.*—This class includes species having a single or forked taproot along which numerous short laterals are spaced. The eleven species falling in this category are:

## ANNUALS AND BIENNIALS

*Agoseris heterophylla*  
*Amsinckia rugosa*  
*Arabis perelegans*  
*Collomia linearis*  
*Gayophytum diffusum*  
*Lactuca scariola integrata*  
*Silene* spp.  
*Spraguea nuda*

## PERENNIALS

*Aplopappus lanuginosus*  
*Crepis* spp.  
*Viola purpurea*

The annual and biennial forbs develop a taproot 15 to 120 cm in length with many small laterals, usually less than 10 cm long, spaced along its entire length. The roots of perennial forbs in this class penetrate to depths of more than 200 cm, but otherwise are similar to those of the annual species.

## COMPARATIVE EFFECTIVENESS OF CLASSES

The four classes of root systems described above differ widely in depth of penetration, zone of greatest concentration, and number of roots per plant. Differences in such pertinent root characteristics clearly indicate variability in the effectiveness of these classes of plants for holding topsoil in place.

The perennial grasses, all of which have fibrous root systems, are unquestionably the most valuable soil binders of the Boise River watershed because they produce a great profusion of roots immediately below the surface of the soil. The interwoven mass of fibers thus produced even by small fibrous-rooted plants tends to bind the soil together at the sur-

face where the forces of erosion are most active.

Semifibrous-rooted species appear to be nearly as valuable for stabilizing watershed soils as the fibrous-rooted plants, but they are not very common on the watershed and hence are of minor importance in watershed management.

The semitap- and taprooted classes, though very well represented on the watershed, appear to be much less valuable for this purpose. These plants lack root characteristics which make effective soil binders. The semitaproot system, which in many cases almost completely ramifies a large block of soil below the 100-cm level, produces but few roots in the upper 40 cm of soil. The taproot class, in general, containing annual and biennial forbs which produce single taproots with few laterals, appears to offer even less promise as a soil stabilizer.

#### COMPARATIVE EFFECTIVENESS OF COMMUNITIES

The relatively greater effectiveness of fibrous, as compared with semifibrous, semitaproot, and taproot systems, is even more apparent when communities of root systems are considered. A comparative study was made of climax communities typical of virgin range and composed mainly of fibrous-rooted species, and the pioneer communities of overgrazed range on which taprooted species are dominant.

The scattered bunch pattern portrayed by the aerial portion of the climax community is in direct contrast to the complete ramification of the soil mantle by the underground components of the perennial grass species. The lateral spread of the fibrous root systems is largely responsible for this condition. The roots of perennial grass plants 5 cm in diameter were found commonly to occupy a column of soil 50 cm in diameter. The underground part of this climax community seems especially well adapted to

maintain the topsoil in an open condition conducive to absorption yet tightly bound against the action of surface run-off water.

In the bisect through the pioneer community, the only fibrous-rooted plant is a single specimen of *Agropyron inerme*, a relict of the original cover. The failure of the roots of the members of this community to permeate the upper few centimeters of soil is clearly in evidence. *Bromus tectorum* is probably the most effective member of the community, but even this species lacks the lateral spread characteristic of the perennial grasses found on the virgin range.

Study of the relative rates of erosion on virgin and depleted range areas substantiates the conclusion that the fibrous-rooted species of the climax community are much more effective in reducing soil washing than are the taprooted species of the pioneer community (6). The few areas on the watershed which have been protected from excessive grazing, and which, as a result, support a good stand of fibrous-rooted grasses, have accumulated a deep topsoil rich in soluble plant foods and unbroken by gullies of any kind. Torrential summer storms or rapidly melting snow produce little, if any, surface run-off due to the friable soil and the numerous root channels which allow water to enter the soil freely. In contrast, erosion on depleted areas of the watershed is excessive, even on the more moderate slopes. During the past decade, run-off from torrential summer storms and melting of snow in the spring has cut numerous gullies sufficiently deep to expose bedrock in areas vegetated by pioneer communities. As a result, the content of soil nitrogen, phosphorous, and organic matter has been seriously reduced.

In all probability, the critical erosion problem of the Boise River watershed is a direct result of a change in vegetative cover from the climax community of fibrous-rooted species to communities of plants whose root systems have only a

limiting binding influence on the soil. Restoration of the original cover, or of any cover made up of fibrous-rooted species, will do much to alleviate the range-watershed problem which has developed on this area. Fortunately, the improved range management practices which are being put into effect on the watershed are designed to favor the perennial grasses which are not only the most desirable forage plants, but also the most effective soil binders.

#### SUMMARY

1. Because of a critical erosion problem on the Boise River watershed in Idaho, the Intermountain Forest and Range Experiment Station, in collaboration with the School of Forestry, University of Idaho, has made a study of the root systems of the principal herbaceous plants of this important range-watershed area. The root systems of 50 species were excavated and charted, and bisects showing the interrelationships of all of the plants in several communities were also studied.

2. Four classes of root systems were recognized:

a. Fibrous root systems, which more or less completely fill the upper layers of soil with a close network of tough fibrous roots.

b. Semifibrous root systems, the roots of which are similar to, but larger and not nearly as numerous as, those of fibrous-rooted plants.

c. Semitaproot systems, which have few roots in the surface soil layers, but which branch rather profusely in the subsoil.

d. Taproot systems, which have straight taproots with little or no branching and few laterals.

3. The bisects indicate that communities, such as those typical of virgin range land, which are composed principally of fibrous-rooted species, fill the surface soil with a dense mass of roots which effectively control erosion; while communi-

ties typical of depleted range land, composed principally of taproot and semitaprooted species, have little soil binding power.

4. As a result of this investigation, it appears that the erosion problem of the area is largely the result of the replacement of fibrous-rooted plants by those belonging to the taproot and semitaprooted class, and that effective rehabilitation can be attained by a reestablishment of the original grass species or similar fibrous-rooted plants.

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# REDWOOD FORESTRY PROGRAM JEOPARDIZED BY PUBLIC APATHY TOWARD FIRE<sup>1</sup>

By EMANUEL FRITZ

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The author uses the redwood region as an example to show what responsibility the public has in effectuating better forest land management plans. He implies here that the citizen should cease criticism of private logging operations unless he is willing to do his share in preventing fires and improving public forest protection agencies. In 1936, he reports, the private forestry programs were given a serious setback by fires set by incendiaries and others set by ranchers and allowed to burn without adequate control.

FOR half a century, the public has decried destructive handling of forest lands and has been very critical of those whose business it is to convert forests into lumber and other products. This has been particularly true of the redwood region of California, naturally so, because, of all the magnificent forests with which nature has endowed this country, the redwood forest is the most unique and the most outstanding. The entire world is interested in our justly famed redwoods, and yet, I fear that our own closeness to them has made us regard them less highly than they are regarded outside the boundaries of our own state.

There is no denying that past logging methods have been destructive. There were some very good reasons for this and the results should not be blamed entirely on those whose legitimate business it is to convert the trees into useful products of commerce and industry. The public itself must share the blame. It has placed in the way of the timber operator certain obstacles, serious enough to make the more conservative handling of the forest of questionable business merit. One of these obstacles is the lack of adequate protection of forest property by the public. It is this obstacle to which I shall limit myself in this paper. For its alleviation,

we need your help. But, first, I must acquaint you with what has been going on recently in the redwood region.

Some great and very significant changes have taken place in the handling of redwood forest lands. Redwood lumbermen are making substantial and laudable progress in meeting the public's demand to cease the old destructive methods. In fact, they are already ahead of the public in doing their part. No longer is all the land completely stripped and abandoned as it once was. Private fire protection effort is better than it ever was and it is constantly improving. The method of logging now calls for the cutting of only the mature merchantable timber and the preservation of the rest. The trees left standing are largely immature individuals, but, as they make further growth, they will form a sizable nucleus for a second cut twenty or thirty years hence. In the meantime, these same trees will cast seed from which young trees will spring to fill the gaps left by those which were cut. This improvement is made possible by the development of the Diesel-powered tractor, a comparatively new logging device. It is an expensive piece of machinery, but it is very effective and fits almost perfectly into redwood forestry. It is the desire of the operators to take advantage

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<sup>1</sup>Presented before Annual Meeting, California State Chamber of Commerce, San Francisco, Calif., November 19, 1936.

of the inherent possibilities of this machine for logging in a constructive manner. For the first time, it seems possible to meet the public's clamor for better handling of timber. This program is now in its third year, and follows an earlier program under which the forest was clear cut and then planted. The new program is superior to the old, because, under it, young trees are saved and we thereby get a running start toward a second crop. It is also more certain than planting; furthermore, it does not strip the country clean and make of it an eyesore. Logging, under this program, is of a selective type, and, therefore, it is called selective logging. Areas so handled do not lose all of their natural beauty from the tourists' standpoint. What loss there is, is temporary and is quickly corrected by nature—if nature is given a chance. Federal and other foresters who have inspected the results of this new program have praised it and they look for even better results in the next few years. But there is a serious threat to the continued success of the redwood forestry program. It has to do with promiscuous, uncontrolled, sometimes malicious use of fire in or near the virgin forest and on reforestation cut-over lands.

It is not enough to save certain trees from cutting. They must be preserved against injury or destruction by fire. This is a fundamental principle in forestry. Protecting the seed trees and seedling growth is the forester's hardest job and the one in which the public plays a big part. We know now how to log ripe old-growth timber without destroying the unripe. We also have learned that, more than ever before, we must keep fire out of the forest during logging operations and while young trees are being established. But actually to keep it out is another matter. Of course, we must use fire to consume the large amount of slash that develops from the felling and yarding operations. Formerly, this slash was

burned broadcast at any season and before the logs were removed. But under a program of selective logging slash dare not be burned during the very high hazard of our hot dry season. The present redwood forestry program calls for burning the slash only after the first soaking rain in the fall and before the dry spring has set in. At such a time, fires can be controlled and the damage to reserved trees can be kept small. At other seasons, fires cannot be controlled with certainty or with economy. Once slash is burned, and seedlings begin to appear fires must be excluded until the little trees are well established.

This year, we had a very bad period of fire weather throughout September and October. There were many fires in the redwood country from Santa Cruz County to Del Norte. Some were disastrous to our recently selectively logged areas and others did much damage in our state parks. The timber operators had carefully kept fires out of their 1936 slashings and were awaiting the rainy season to burn the refuse. But what happened? Early in September, a few ranchers were given burning permits, and, according to an old custom, set fire to their ranges, purportedly to burn off shrubby growth to improve the pasturage. They picked the hottest and driest period, expecting to get quick pasturage. The air for many miles was filled with smoke. Under the cover of this big smoke, other ranchers set off additional fires without permits. Furthermore, the protection offered by the smoke against discovery encouraged the confirmed incendiary to set fires in inaccessible places. Some hunters too, according to another old habit, set fires to drive game. Rather poor sportsmanship to be sure, though it's an easy way to get game. Incendiaries and hunters pay no regard to property lines in setting their fires. And neither do all ranchers.

I shall not go into the merits of burn-

ing ranges to improve pasturage. It is a controversial matter in many respects. But it cannot be controversial on these points: the danger of setting fires during the most hazardous periods, and the failure to keep them under control. If a rancher believes he can improve his range by periodically burning the brush; if he picks a time that will not favor disastrous fires, and if he keeps the fires on his own property, there will be little complaint. In the redwood region, many of the stock ranches are on old cut-over land which is being converted into pasturage. Adjoining these areas are virgin timberlands and other cut-over lands that are not intended for stockraising. During the past season, as in many previous seasons, fires set by ranchers were given too little or no attention, and were left to run where they would. Some of these fires encroached and ran over recently selectively logged lands, virgin timberland, state parks, and reforesting cut-over lands. Some of our worst fires were set, not on the burner's own land, but on neighboring land, which he hopes to trespass upon with his stock later on. This act is probably motivated by a feeling that cut-over land is anybody's land.

The incendiary is in a separate category. Whereas the rancher's fires are usually set with the thought of improving the pasturage, even if in trespass, the incendiary is motivated by destructiveness.

In the cities, we have efficient fire departments maintained by the public. In the cities, the people are fire conscious. In the cities, and elsewhere too, it is arson to burn down another's house. But transfer the same citizenry to the woods and you find an entirely different attitude. No longer does the individual show the same respect toward the property of another, no longer is he so fire conscious. In the woods he can set fire to another's property without much fear of punishment. To set fire to timber is only a

misdeemeanor in the eyes of our laws, whereas arson is a felony. If a man is caught firing the timber of another, it is a rare justice of the peace who has the personal interest or the courage to apply the laws and administer sufficiently exemplary punishment. The justice of the peace himself is too often not fire conscious; thereby reflecting the general attitude of the local forest community. This will seem strange to those who live in non-forested regions; nevertheless, it is true. Some very flagrant derelictions of duty can be cited.

I hope I have made it clear that, despite its demands for the better handling of forests, the public itself makes such handling practically impossible. There is not only apathy toward forest fires, but there is a deeply rooted belief that the forest should be burned periodically to prevent large conflagrations later. During the recent fires, editorials were written in several newspapers demanding a change in our state fire laws to make fires compulsory in the fall—our most hazardous and most dangerous period. Oregon has had such a law for some time. Fires were there set according to law, and, I am told, were even ordered by state officers. The result? Far worse fires than we had in California and the destruction of a good sized town. The theory of periodic burning sounds good, but it is full of danger. Proponents of this theory cite the Indian as a wise forest manager because they believe him to have set fires each fall to keep the woods open, and therefore, safe. The proponents do not consider the fact that conditions have changed since Indian days. We now have many more people in the woods; we are trying to raise trees, whereas the Indian sought to raise forage; because of overgrazing, many of the best ranges have become unable to cope with the encroachment of brush; we have logging slash areas, whereas the Indian had none, and

we have reforesting cut-over areas on which brush is a necessary prelude to soil rehabilitation and the protection of seedlings. Other changes might be cited. The situation is now entirely different and far more complex.

Nothing can be gained by going into detail here as to the merits or demerits of periodic burning in the woods. But this is certain: As long as there is a dangerous clash of opinion as to what the policy toward fire should be, we cannot go ahead with our redwood forestry program with any degree of assurance that it has a chance for success. This also is certain: that there must be a clear distinction between burning in the woods and burning on the range; that if burning has a place in the forest, it must not be conducted in the most dangerous period; that it must be limited to the land of the man who wants to burn and that he must prevent its running to the land of another; that incendiarism must be made a felony; that a better understanding must be reached between stockmen, timber owners, public foresters, and the general

public; and that we must have a more effective state forest fire fighting organization.

May I suggest, now, that the State Chamber of Commerce can be of inestimable service in helping solve this vexing fire problem. There are many interests to be considered. None of them agree on all points. All of them can't be right. Perhaps, there are extremists on both sides of the controversy.

I hope you will find it possible, through your conservation department, to induce each interested organization to meet and determine what policy it desires to have followed and why. Then, when all have come to their own conclusions, invite them to have representatives meet to compose or iron out the differences and then arrive at a policy that will be acceptable to all.

Once we solve the fire problem, the public can be assured that in not many more years it can be as boastful of its redwood forestry program as of its redwood forests and parks.

# RECREATIONAL SURVEYING

By L. BERRIMAN AND W. FISCHER

*U. S. Forest Service*

In 1935 Region 5 of the Forest Service began the preparation of a recreational management plan. In the following paper the authors describe the various steps involved and methods used in making such a plan. Although forest areas have long been used for recreational purposes, the technique of recreational surveying is a recent development to which the Forest Service has made a significant contribution.

FOREST recreation, one of the oldest forms of forest use, is the last of the forest uses to be accorded major recognition. It is the phase of forest use in which the people at large are most interested. Due to the increase in transportation facilities; the widespread use of the automobile; and the growing realization of the physical and mental benefits derived from forest recreation, the last few years have shown the need of directing management of this utility in a manner commensurate with its importance. This requires planwise management with consideration for present and future needs.

To make such a plan requires knowledge of the kind, quality, and quantity of recreational resources, knowledge of the present and probable future demand on these resources and their coordination with other uses. Heretofore, recreation use has become established without regard to the best use of the land. In some cases development has taken place where it should not have taken place, and, on the other hand, on places where development should have taken place, it is lacking. In order that future readjustments and development may be made in the most efficient manner, it is necessary to have available all information affecting recreational use.

About the middle of 1935, Region 5 of the Forest Service initiated the preparation of a "Recreational Management Plan", the object of which was to effect a coherent plan which will provide for

the appraising, developing, and administering of all recreational phases of forest land in such a way as to, provide, adequately, for present and probable future demands; to assign value to recreation in order that it may be weighed with other uses and injected into the whole land valuation scheme.

The first step in formulating this Recreation Management Plan was the survey or the collection of the basic data. The survey was divided into four parts as follows:

1. Inventory of all existing and potential recreational features and developments.
2. Study and predictions of present and future demand for all phases of recreation.
3. Coordination and conciliation of recreation with other forest uses.
4. The development plan which was based on the three previous steps involved the establishment of priorities, and the designation of uses to sites to which they are best suited.

The first step, inventory of recreation resources, involved the major portion of the field work. The object was to learn the kind, quantity, and quality of recreational resources, both existing and potential, of the principal mountainous area of California, regardless of ownership.

The recording of existing development was comparatively simple. Most of the required information such as capacity, amount of use, and character of developments can be obtained from the operators.

However, the assigning of recreational values is not so simple. To give a value to spiritual, social, and inspirational features is difficult, but essential.

In order to classify all the diversified areas and types of recreational resources, the forest areas were divided into districts comprising about 200,000 acres, characterized by similarity in recreational type. These are similar in many ways to the administrative ranger district on National Forests, but do not necessarily coincide with them. The districts were further broken down into four or five units usually comprising a single drainage characterized by similar recreational type, cover, and accessibility, merely classifying areas to finer degrees than was possible in recreational districts. Units were divided into sub-units of about 10,000 acres in order to obtain a still finer classification than in the unit division. The boundaries of these divisions were usually determined by topographical features. On these districts, units, and sub-units, all the pertinent information on recreational values, for present and future use, was gathered in outline form. This included all information affecting hunting, fishing, wildlife, accessibility, scenic and inspirational values, and other attractions.

Within the unit the areas suitable for occupancy were located and investigated. Being portions of the unit, these tracts of land are called fractions, and vary in size from an acre to several thousand.

All land under 45 per cent slope and in more valuable areas slightly in excess of 45 per cent slope was considered habitable and is reported on in a fractional writeup. Slopes of 45 per cent and less were further broken down; that below 10 per cent to be considered for camp ground development, and that between 10 per cent and 45 per cent for development other than camp site. Thus, slope was the limiting factor for determining the class of use.

There may be many fractions within a

unit, their boundaries being determined by similarity in cover, common source of water accessibility, small drainage basin, or similarity in recreational attraction. All information such as size, probable capacity, ownership, service and supplies, nearness to towns, cities, and all data pertinent to the development of these areas was collected. To indicate location and give further information on usable areas, sketch maps of all sub-units and important fractions were prepared.

All fractions were rated by a color system based on the pure physical desirability of the fraction itself. In this scheme there were four divisions, and a specific color was adopted to indicate the desirability of sites or divisions. To govern in the assigning of colors to sites, the ideal recreational area was defined. The ideal area must have certain requirements. If it lacks one requirement it is dropped to the next lowest color rating; if two, it is dropped to the next lowest; and so on to the lowest rating. In this manner it was possible to pick out the most desirable areas for recreational development. This rating was made purely on the physical or natural characters on the ground; accessibility or nearness to towns was not considered.

The second or letter rating took into account all factors in and affecting the present value of the fraction, including the personal opinion of the man who made the investigation. These letters were put on the fractional report and not on the sketch map. They are merely an evaluation (rating) of the present day desirability of the fraction.

All the aforementioned information was gathered on a master map, showing all district and unit boundaries, fractions in color, numbered to identify them with the written reports.

At the completion of this phase of the field work we had the following information:

1. Large forest areas divided into rec-

reational districts about 200,000 acres in size, characterized by such features as similarity in cover type, topography, or altitude.

2. Districts divided into recreational units about 50,000 acres characterized by recreational features to a finer degree than in districts; usually a drainage basin.

3. A division of districts into sub-units of about 10,000 acres, breaking down the diverse recreational features of the unit.

4. Recreational sites or fractions upon which development is possible, ranging from about one acre to several thousand acres; classified as to density, kind, and quality of recreational attractions, with detailed information relevant to its possible developments.

5. Sketch maps of sub-units and fractions showing size and shape of areas, slopes, and locations of important features.

6. A master map either on  $\frac{1}{2}$ -inch or 1-inch scale, preferably the latter, showing all division boundaries and fractions in colors with file numbers to identify the map information with the detailed reports.

To round out the information necessary to planning, the following information was gathered by districts from game wardens, forest rangers, and others who could give accurate information:

1. Existing and potential hunting and fishing possibilities.

2. Existing and potential trails and trail areas.

3. Tourist pastures existing and potential.

The remaining steps in the survey, consisting of population and demand studies and their effect on recreational land requirements, and studies of the conciliation and coordination of recreation and other forest uses, was primarily an office job.

There are a number of ways the curve of demand for recreation on forest areas can be projected. The foremost is probably the projection of the past increase qualified by accepted studies on population trends.

Conciliation and coordination of uses require the study and conference of experts along all lines of land use.

The final plan was developed from these three steps. Requirements were set up, sites were selected for development, uses adjusted, and priority of development laid out.

Assuming that we have devised a scheme to set up a recreational development plan, what are the obstacles in the way of carrying the plan to its logical conclusion? Such difficulties, as errors in projecting requirements, can be corrected by periodic revision. Probably the major difficulty to be encountered in any land plan is the diversity of ownership. Where will Mr. Jones' land fall into the scheme of things? Will or can he handle his lands in such a manner as to upset the applecart? Will he plan the use of his land along with and commensurate with his neighbors?

Such difficulties as these should be anticipated and machinery set up to keep a record of developments and requirements and the adjustments needed at all times.

# NEW YORK STATE'S FOREST PRESERVE POLICY<sup>1</sup>

By WILLIAM G. HOWARD

*New York State Conservation Department*

In a previous issue of the JOURNAL Dr. Illick discussed in detail significant forestry trends in New York state. In the present article, Mr. Howard discusses the Forest Preserve policy of the state. These two articles give a clear-cut picture of one of the most interesting state forestry developments in the entire country.

SECTION 7 of Article VII of the New York State Constitution is the corner stone of Forest Preserve policy, but as such gives assurance of a substantial foundation upon which the superstructure of Forest Preserve administration is erected. It defines in most general terms the type and kind of development, or lack of development, that should be applied to the Forest Preserve.

It is worth noting that the provisions of Section 7 of Article VII were not a part of the original Forest Preserve conception. The constitutional amendment was adopted in 1894, eleven years after the establishment of the Preserve, and nine years after the creation of the Forest Commission to administer it.

Let us see what the original plan contemplated. The State Park Commission of 1872 and the so-called Sargent Commission of 1885 mentioned not only recreation and watershed protection, but also timber supply.

In fact the State Park Commission in 1873 said: "At first sight it may appear that the absorption of all this vast forest (practically the only lumber region remaining in the state) into a state park would amount to the immediate annihilation of that trade (the lumber industry). The idea of such an unproductive and useless park we utterly and entirely repudiate. The park should be eminently a timber preserve and reserve."

The Sargent Commission of 1885 visualized three important functions that might be performed by an Adirondack Forest Preserve, namely, protection of the watersheds of important streams, a recreation area, and a future timber supply.

Lack of an adequate field force made it impossible for the Forest Commission to protect the Forest Preserve from trespass. That condition and the resulting timber thefts is what aroused public opinion to adopt Section 7, Article VII of the state constitution in 1894 as a positive assurance that this valuable natural resource would not be dissipated by theft.

The vital part of this fundamental law reads as follows: "The lands of the state now owned or hereafter acquired constituting the Forest Preserve, as now fixed by law, shall be forever kept as wild forest lands. They shall not be leased, sold or exchanged or be taken by any corporation, public or private, nor shall the timber thereon be sold, removed or destroyed."

Obviously, these restrictions limit the functions of the Forest Preserve to protecting the watersheds of streams and providing a vast recreation area. While realization of the importance of watershed protection is about the same now as it was fifty years ago, probably no one in that earlier day foresaw that recreation would assume the importance it has today,

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<sup>1</sup>Presented at the meeting of the New York Section, Society of American Foresters, January 22, 1937.

or realize what a great asset a vast wilderness park in the Adirondacks would become for the people of the state. Even now it may be questioned whether the average person realizes how unique the Forest Preserve is amongst public reservations in the East. It is virtually the only wilderness area in public ownership outside the National Parks that is assured for public use in perpetuity. Moreover, its accessibility to the large centers of population make it usable by many persons whose vacation time is extremely limited.

Certain interpretations of the meaning of the constitutional amendment have resulted from court decisions rendered from time to time. The last one of these, and the one that has given the most accurate definition of the authority of the department in administering the Forest Preserve, is the decision handed down by the Court of Appeals in the so-called Bobsled case in 1930. This opinion contains the following statement: "The purpose of the constitutional provision, as indicated by the debates in the Convention of 1894, was to prevent the cutting or destruction of the timber or the sale thereof, as had therefore been permitted by legislation, to the injury and ruin of the Forest Preserve. To accomplish the end in view, it was thought necessary to close all gaps and openings in the law, and to prohibit any cutting or any removal of the trees and timber to a substantial extent. The Adirondack Park was to be preserved, not destroyed. Therefore, all things necessary were permitted, such as measures to prevent forest fires, the repairs to roads and proper inspection, or the erection and maintenance of proper facilities for the use by the public, which did not call for the removal of the timber to any material degree."

The basis for much of our Forest Preserve policy is the numerous opinions that have been rendered from time to time by succeeding Attorneys General. These opinions have not only defined the De-

partment's authority, under certain sections of the Conservation Law, but also have sought to clarify the meaning of the provisions of Section 7 of Article VII of the Constitution as it relates to the duties of the department.

The development of our present Forest Preserve policy has been going on ever since the creation of the Forest Commission in 1885. From 1885 to 1890, administration of the Preserve included only rather feeble efforts at protection and certain more or less academic discussions of problems of forest management, including talk of the removal of mature timber and the reforestation of denuded lands. In 1890 when funds were appropriated for acquiring additional lands, the matter of extension of the Forest Preserve began to receive attention. Upon the adoption of the constitutional amendment in 1894, the utilization of timber ceased to be a factor in handling the Preserve. With the turn of the century, real progress was made in the successful reforestation of state lands.

The extensive and destructive forest fires of 1903 and 1908 aroused the public to an appreciation of the need for an adequate fire control system, which resulted in the creation of a force of forest rangers and the establishment of fire observation stations in 1909. While the primary function of the ranger force was to control fires, this force gave the Forest Preserve the first protection it had ever had against timber stealing on a wholesale scale. Effective protection against both fire and trespass dates from that time.

During the first two or three years, the newly created ranger force discovered a number of extensive trespasses on state land involving the cutting of tremendous quantities of timber. For instance, one case was settled by payment of \$26,000, another for \$10,000. There have been no trespasses of such magnitude since then.

The next decade was devoted mainly to perfecting the technic of tree plant-

ing and expanding the production of forest planting stock in state nurseries; to improving methods of fire control and amplifying the system of fire observation stations. During this period also, the use of automobiles increased enormously; a system of first-class highways gave access to many parts of the Forest Preserve; the idea of motor camping was just beginning to take hold with the public. The trails to the fire observation stations were maintained in good condition, and the public was encouraged to use them. People began to visit the towers in large numbers.

When the Constitutional Convention of 1915 met, the Conservation Department was engaged in a serious effort to clear up several illegal occupancies of state land in the Forest Preserve. The Commissioner, feeling that the leasing of campsites would help materially in clearing up this situation, recommended to the Convention that Section 7 of Article VII be amended to permit the leasing of campsites. This proposal was disapproved by the Convention.

For thirty-five years after the establishment of the Preserve, its administration included only protection, reforestation and extension through the acquisition of additional land. From the earliest days recreational use of the Forest Preserve had been extensive. It was well recognized and even encouraged, but it received no official stimulus until 1920 when with an appropriation of a meager \$2,500, the first steps were taken to develop the recreational facilities of the Preserve through the establishment of public campsites along main highways and the construction of pedestrian trails and shelters of the Adirondack open camp or lean-to type.

That, in brief, is the history of the development of the present Forest Preserve policy, a policy that can be described as it exists today; but it is a policy which should be flexible enough to take advantage of scientific advance in methods of protection and to give recognition to

changes in the social and economic lives of our people. For instance, thirty years ago no one foresaw the present day demand for public campsites and the splendid service the Preserve could render the people of the state in supplying that demand. Even five years ago only very few persons realized the extent to which public interest in skiing and winter sports generally would be aroused and the consequent natural and reasonable public demand that trails for cross-country skiing be provided on the Forest Preserve.

Let us analyze the present Forest Preserve policy and see what its elements are.

Protection, of course, is of paramount importance, for unless we protect the forest we have, there will be no need to give heed to any other problems of administration. Fire control comes first. That involves a system of fire observation towers served by telephone lines. These towers must be properly placed and numerous enough to cover practically every acre in the Adirondacks and Catskills. Near each fire tower a cabin for the observer is placed, so that he may be on the job whenever needed.

Successful fire control depends on prompt action with adequate equipment. Great progress has been made in recent years in developing motorized forest fire fighting equipment that saves time and labor, and does far more effective work than the older hand methods ever could. To get the best results with the new equipment, isolated portions of the forest have been made accessible by so-called "truck trails". These are narrow roads over which motor apparatus can be driven. All truck trails in the Forest Preserve are barricaded with locked gates to which only the rangers have keys, and public vehicular traffic is prohibited. These truck trails are in reality nothing new, for it has long been the policy of the department to renew bridges and to keep old tote roads cleared of brush and tree

growth to permit access in case of fire. All of the truck trails follow existing wagon roads or tote roads.

Where areas of forest plantations or valuable stands of natural timber lie along main travelled highways, they need protection from the hazard of burning tobacco thrown from passing automobiles. This protection is provided by so-called "fire lines", narrow strips from five to fifteen feet wide from which all vegetation is removed and the mineral soil exposed. If a fire starts in dry grass by the roadside, it will be checked by this fire line. These fire lines may be further reinforced by the removal of brush and dead and down material for a zone of fifty feet or more back of the fire line, in order that even though a fire should jump the fire line, it would find little fuel and could be more easily controlled. In some cases where water supplies are deficient, holes have been dug where water will collect and will be available in case of fire.

Fire, however, is not the only enemy of the forest. Trees suffer from diseases as do humans. The best known disease attacking trees in the Forest Preserve is the white pine blister rust. This is a fungus that kills white pine trees. Its control is accomplished by removing all currant and gooseberry bushes from within and adjacent to the timber stand to be protected. There are hundreds of thousands of acres of white pine in the Forest Preserve from which blister rust must be eradicated if we are to save these beautiful and valuable trees.

Insect control presents another problem. A few years ago the gipsy moth threatened to spread from New England to invade the forests of New York state. Only prompt and vigorous action has kept it out. Pests like the white pine weevil and the fir bark louse have threatened extensive damage to trees in the Forest Preserve. The control of the former insect involves the removal of parts of trees growing on state land.

The control of the latter insect requires the removal of entire trees while they are still living. These control operations are being carried on in accordance with opinions received from the Attorney General to the effect that work of this character necessary for the protection of the Forest Preserve must be carried on, even though the cutting of trees is involved.

Last, but by no means least of the protection problems is that of protection against man. Valuable stands of timber on state land often in the midst of large areas of cut-over private lands tempt the cupidity of the unscrupulous and only constant vigilance by an alert field force can prevent extensive trespass. When we consider that there are some 7,000 to 8,000 miles of boundary lines of Forest Preserve lands, many of them marked poorly or not at all, the difficulty of the task is apparent. It requires three survey crews working continuously to make only those surveys of vital importance to detect or prevent timber trespass. The more rapidly this work can be done and the boundaries of state land clearly marked, the sooner trespasses due to ignorance of the location of state land will cease. This is one of the most important projects to be carried on for the protection of the Forest Preserve from trespass.

Then there is the form of trespass known as occupancy, where persons have erected camps, cottages, or even hotels on state land either because of uncertainty as to title to the land or in a barefaced effort to steal a choice bit of property. Such cases of timber trespass may involve extensive litigation before the state's interests can be protected. The legal part of this work is handled by the Attorney General of the state.

Naturally, the matter of land ownership is vital in connection with the Forest Preserve. An extensive library of title papers and maps must be maintained in the Albany office of the Conservation Department so cataloged and indexed

that it can readily be consulted. Titles to lands acquired in the earlier years have sometimes been found defective, and examination of titles is going on continuously.

For more than forty-five years, appropriations for the acquisition of additional lands for Forest Preserve purposes have been made from time to time. The last and largest funds were the bond issues of 1916 and 1924—\$7,500,000 and \$5,000,000, respectively. Selecting lands wisely and acquiring them economically both by purchase and by appropriation involves a vast amount of work. Each area to be acquired must be appraised, negotiations conducted with the owner, and the title examined before it can be brought into state ownership. Acquisition has been mainly by purchase, and recourse has been had to appropriation only in the case of certain areas deemed to be of vital importance to the Forest Preserve, where the owners were unwilling to sell at any reasonable price.

A detailed policy of land acquisition has been adopted in which the more important purposes to be kept in mind in selecting lands for acquisition are listed as follows:

1. The extension of state lands suitable for recreational use by the public and for the protection of aesthetic features.

2. To assure the maintenance of protection forests on the watersheds of important streams, in order to prevent erosion and equalize water runoff.

3. The consolidation of state holdings to reduce administration expense and shorten boundary lines.

4. To perfect the state's title to lands and reduce the cost of litigation.

Last of all is the matter of the development of the Preserve. Obviously, this must be limited by the restrictions imposed by Section 7 of Article VII of the Constitution. As far as forest management is concerned, development is re-

stricted to the planting of trees on denuded areas and the cultural treatment of those plantations after they are established. From the beginning of the century a consistent effort has been made to reforest all open areas in the Preserve where the state's title to the land was felt to justify such action. Twenty years ago this involved devoting the greater part of the output of the state nurseries to this use; but as the plantations were extended and nature unaided reforested old burns after a fashion, the plantable areas have been reduced until they are today almost negligible.

About ten years ago it was apparent that the earlier plantations on the Forest Preserve were badly in need of cultural treatment if they were ever to produce respectable forests. The opinion of the Attorney General was sought as to whether such work, particularly pruning and thinning, could properly be carried on upon Forest Preserve lands. He held that it could, so every effort has been made through the labor of rangers and Civilian Conservation Corps camps to give these plantations the treatment they needed to keep them healthy and stimulate their growth.

Development, to most persons, connotes the building of public campsites and other recreational facilities such as trails and shelters. This work, started sixteen years ago, has assumed large proportions but through it all, the spirit of the constitutional amendment has been observed. As a matter of fact, one of the original purposes of establishing public campsites was to get better protection against fire, by concentrating camping within a limited area which could be surrounded with a fire line.

The public campsite is an area prepared for camping with tents or trailers only. No cottages or even tent platforms are provided. The only facilities furnished are (1) space for pitching a tent or parking a trailer; (2) an open stone

fireplace for cooking; (3) a supply of pure drinking water; (4) sanitary facilities, and (5) bathing facilities where the campsite is located on a suitable body of water. On a few campsites, assembly areas, with rustic seats and other accessories, are provided for campers' meetings for educational and recreational purposes. Brush must be cleared out and the ground smoothed to provide a sanitary and comfortable tent site, but beyond that the camper must accept the forest conditions as Nature has created them.

In the building of trails, the thought has always been uppermost that too many trails are worse than not enough. While there are some 600 miles of marked trails in the Forest Preserve at the present time, only a small percentage have been cut through the wilderness by the Conservation Department. Most of these trails follow old trails or tote roads that existed for many years before they were marked and, where necessary, improved by the department. A system of standard signs and trail markers has been devised so that all trails can be followed confidently by anyone, even though he be unfamiliar with the woods. Trails have been marked to points of outstanding interest, such as mountain peaks, lakes, and ponds. Certain through trails of considerable length have been provided for cross-country hikers. At the same time, certain trailless areas including a number of the high mountain masses have been left deliberately for those who prefer to travel where there are no trails.

In certain parts of the Adirondacks there has been a demand for bridle paths and a few of our trails have taken this form. The bridle path has to be only slightly wider than the pedestrian trail, its surface needs to be smoothed to a somewhat greater extent, and boggy, marshy places must be corduroyed or bridged.

Then, within recent years has arisen the demand for ski trails. When on level

ground these need be little, if any, wider than the ordinary pedestrian trail. When, however, they are on steep slopes, they need to be widened and the branches of trees on the sides need to be trimmed to a point higher than that required for summer use of the trail. An opinion rendered by the Attorney General is to the effect that these ski trails can be constructed where the removal of timber to any material degree is not involved. Acting under this authority, the Department has constructed and is continuing to construct a reasonable mileage of cross-country ski trails. These will not be the type of downhill ski trail desired for racing but will be through cross-country ski trails, the primary purpose of which is to enable persons to travel the Forest Preserve on skis in winter to an extent comparable with summer travel on foot. As this is written, the Department is preparing a program of ski trails for the entire Forest Preserve, that is to say, for that portion of the preserve where it is felt that there should be any trails.

Because of the appeal of the Adirondack open camp and the desirability of some type of shelter on the more remote trails, the policy of constructing open camps where public use shows they are needed was adopted years ago and is being followed consistently. These camps are for transient use only.

There is considerable camping on undeveloped areas in the Forest Preserve. For this type of camping no permit is required of transients who camp less than three days in one place, but for a longer stay, a permit must be obtained from a forest ranger. The building of permanent tent platforms is allowed under a permit, which specifies that the platform become the property of the state as soon as constructed. The permittee is, however, given preference in the use of the platform. His use is not exclusive, for anyone else may be permitted to occupy it when it is vacant. His use must be continuous dur-

ing the life of his permit, for no one is permitted to occupy a site simply by setting up an empty tent.

In order that the public may know of what the Forest Preserve has to offer, a series of so-called Recreation Circulars is published to give full information about camping, campsites, and trails.

In many places on the Forest Preserve, dams were built years ago to impound water for log driving before the land came into state ownership. As these dams rot out and go to pieces, an unsightly marsh is left. For the sake of restoring the scenic values of the former pond and to improve fishing, the Department has, in the past, followed the policy of restoring these old dams whenever possible, provided the restoration did not entail the destruction of any timber in the flooded area. It is felt that in the near future it may even be desirable to create ponds of this kind even where the removal of some trees may be involved, provided "the removal of the timber to any material degree" is not required.

Chapter 275 of the Laws of 1924 provides that the Division of Highways of the State Department of Public Works may occupy state Forest Preserve lands for the purpose of eliminating bad curves and grades and to get gravel and stone for use on roads designated for improvement by the state. The procedure set up under this Act has been that applications for such changes are made by the Department of Public Works to the Con-

servation Department, with maps showing the lands to be occupied. If upon examination the Conservation Department finds that the changes are in accord with the law and the constitution, the application is then approved, provided the use to be made of state land does not entail the removal of timber to any material degree. Each year changes of this sort are being made in connection with the improvement of state highways across Forest Preserve land. In carrying on this work, the Department has done everything possible to get the cooperation of the Department of Public Works in preserving trees and natural forest conditions along the new highways and in getting necessary unsightly cuts and gravel banks replanted as promptly as possible.

Such, in brief, is the state's Forest Preserve policy. It may be summed up in the statement that it contemplates, first, the protection, perpetuation, and extension of the state's vast wilderness park, and second, the administration of that park in such a manner that it shall render the greatest possible service to the people of the state consistent with the mandate of Section 7 of Article VII of the State Constitution. It must seek to maintain and where possible and necessary, to bring back the essential wilderness character of the Forest Preserve; but it must not be a dead hand strangling the best modern methods of protection or public demands for reasonable recreational uses which the authors of Section 7, Article VII, could not foresee.

# STORAGE AND DEWINGING OF AMERICAN ELM SEED

By ERNEST J. GEORGE

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American elm has long been a very popular tree for prairie planting in the northern Great Plains region. Because of the fact that it has been believed generally that American elm seed could not be stored for any appreciable period of time it has been common practice to plant the seed shortly after it matures in the latter half of May and to accept as inevitable the losses resulting from summer drouths and early frosts. In this paper a satisfactory method is reported for storing elm seeds eleven months, thus permitting early spring sowing which results in the production of suitable size stock in one season.

AMERICAN ELM (*Ulmus americana* L.) has proved to be a valuable species for farm shelterbelt planting on the northern Great Plains. It is somewhat more difficult to propagate than most of the other broadleaf species commonly used in that area. Any information that will tend toward the assurance of a crop of seedlings each year should be of interest to nurserymen.

Some of the difficulties confronting the growers of this species are the maturing of the seed crop in the latter half of May, with the consequent possibility of its being destroyed by late frosts or blown off the trees by high winds before it is mature; the supposedly short life of the seed, which makes necessary the planting of it in June or early July when the soil surface is subject to a high evaporation with consequent crusting that prevents emergence of the seedling; the difficulty of sowing uniformly a light, winged seed in an area that is subject to almost constant wind; and the lateness of sowing, which results in too small a seedling the first year and too large a seedling the second year, if moisture conditions are favorable the second season.

The following discussion based on observations and studies over a period of years at the Northern Great Plains Field Station, Mandan, N. Dak., may offer information that will help to overcome these unfavorable factors.

## STORAGE

*Review of Literature.*—Most literature dealing with the propagation of American elm agrees that the seed is short-lived and should be planted almost immediately after collection. Tourney (4) states the seed remains alive but a few weeks after ripening, although mention is made in a footnote that he succeeded in storing white elm seed for one year in dry sand in a box buried 2 feet in the ground under the protection of a building. Laurie and Chadwick (2) recommend sowing the seed as soon as it is ripe in the spring. Bailey (1) recommends the sowing of the seed at once after ripening, although he mentions that some seed may remain dormant until the following spring. Yerkes (5) recommends sowing the seed as soon as it is ripe in the spring. He further states, "The seed loses its viability if kept dry for any length of time".

Steinbauer and Steinbauer (3) conducted experiments to determine the effects of temperature and desiccation during storage on the germination of American elm seed. At the commencement of the experiment part of the seed was desiccated for a 2-week period over sulphuric acid concentrations of 25, 50, 75, and 95 per cent and then stored in sealed containers; part of the seed was stored in sealed containers without desiccation; and part was stored in an open container without desiccation. Before storage, the

various lots of desiccated and undesiccated seed were each divided into three groups, and one group of each treatment was stored at temperatures of 0°, 10°, and 20° C. Germination tests of each treatment and storage temperature were run in triplicate at periods of approximately 4½, 6, 7½, 9½, 11, and 13½ months after the date of collection. The seed was placed between moist blotters in a germinator at 20° C.

At the 11-month period, which would be the most comparable period to actual nursery practice in carrying over elm seed, they found that the seed desiccated over the various sulphuric acid concentrations and stored at 0° gave the best germination results. These results in round numbers were 11, 9, 12, and 12 per cent for the 25, 50, 75, and 95 per cent concentrations, respectively. Results were much higher for all storage treatments at the end of the 9½-month period. This period, however, is too short for actual field practice in North Dakota. At the end of the 13½-month period, germination was obtained only from those seed that had been desiccated. As a result of these tests, they concluded that elm seed goes into a rest period within a few weeks after harvest, and that this rest period terminates approximately 6 months later.

*Discussion.*—Studies commenced at the Northern Great Plains Field Station in 1926 with Chinese elm seed (*Ulmus pumila* L.) resulted in the knowledge that seed of that species could be carried over successfully for a period of 2 years when stored in paper envelopes at office temperature.

American elm seed has lain over in the soil for one year and emerged to good stands the second season, particularly so when the area was mulched and the mulch was not removed until after emergence in the spring. Such seedlings reached suitable transplanting sizes the first season as compared with the two years neces-

sary for the June or July planting.

At the Mandan station the usual practice has been to plant elm seed at the first favorable opportunity after collection. Small experimental areas have been fall planted. Fall plantings gave good stands under irrigation but the tender seedlings were destroyed by early frosts. A late October planting in 1936 emerged to an excellent stand in 1937. Very little of the seed germinated and emerged in 1936.

Resultant stands from the June or July plantings have been very irregular or complete failures owing to a variety of causes, some of which already have been mentioned. In addition, the care used in covering the seed has been an important factor. When fields have been divided into sections for covering purposes, it has frequently been possible to determine the stand where the work of one man let off and that of another commenced.

American elm set a heavy crop of seed in 1936, and a considerable supply was collected before it was quite mature during the third week in May. The seed was spread out on a dry floor for about two weeks to thoroughly dry and ripen. The seed not needed for planting that year was stored, part in closed containers having a reasonably tight-fitting pressed-cover, and part in a container with no cover. All containers were stored in an uninsulated attic of an unheated building. Outdoor temperatures during the storage period ranged from a high of 115° F. to a low of -28° F.

In early April 1937, 100 well-filled seeds from each of the closed and open containers were tested in duplicate for germination. The seeds were placed in a moist blotter in a tray covered with glass at ordinary office temperature. At the end of 12 days an average of 79 and 77 per cent had developed hypocotyls 1 inch in length or more for the closed and open containers, respectively. The seeds from the closed container later

veloped radicles but no hypocotyls. Remaining seeds were still sound but showed no evidence of germination at the end of the fourteenth day when the test was discontinued.

The seed used in these tests was 10½ months old from the date of collection, and the germination results compare with a high of 12.67 per cent for the various treatments described by Steinbauer and Steinbauer (3) at 11 months after collection. Their tests were run between moist blotters in a germinator at 20° C.

#### PREPARATION OF SEED FOR PLANTING

To investigate methods of preparing the seed that would permit machine sowing of elm seed or planting by hand in the presence of light winds, the seed from the open and closed containers was placed in sacks and flailed. The wing and seed membrane was dry and brittle on the seed stored in the open container and was easily removed. More flailing was necessary on the seed stored in the closed containers, particularly so to remove the seed membrane. The removal of this membrane is not necessary except to get uniformity of size for machine planting.

All refuse was removed by running the flailed seed through a fanning mill with the wind cut down to the very minimum. The cleaned seed was 100 per cent good as shown by the cutting test and ran 164,000 to the pound as compared with an average of about 90,000 to the pound for unflailed seed.

No evidence was found that the flailing had broken any good seeds. To determine whether the flailing had caused any injury to the embryo, germination tests were again run in duplicate on moist blotters and also in cans of soil. Through misunderstanding at the time of cleaning, the flailed seeds from the open and closed containers were mixed and this germination test represents a mixture of both methods of storage. Counts of emerged

seedlings were not made until the hypocotyls were 1 inch or more in length. Average results were 80 per cent for the blotter at 10 days and 33 per cent for the soil at 18 days. Damping-off appeared very prevalent in the soil test, 20 or more seedlings having damped-off immediately at emergence. They are not included in the average per cent germination. Seeds in the blotter test had molded so badly at the end of 10 days that it was necessary to discontinue the test.

#### CONCLUSIONS

Field trials in the spring of 1937 have supported the results obtained in the laboratory. Flailed seed was planted with a garden planter on April 15 and in spite of decidedly unfavorable climatic conditions has emerged to an excellent stand. Part of the seed was planted in an open furrow with the shoe and covering attachment removed and part was planted in an opened furrow with the shoe and covering attachment in place. The former method gave a very uniform distribution of seed over the entire 4-inch width of the bottom of the opened furrow. Seed planted by this method was covered by hand. Seed planted with the shoe and covering attachment in place has given a very narrow band and the stand is not quite as uniform as the former method.

The results obtained thus far point to the following facts in connection with the the propagation of American elm: (1) Thoroughly ripened and dried seed can be carried over one year successfully stored either in open or closed containers; (2) A two-years' supply of seed can be collected in those years when a plentiful supply is available; (3) The seed can be dewinged successfully, making possible machine sowing at a uniform rate and not necessarily dependent upon the presence of a day free from wind; (4) The seed can be planted in the spring when the ground is moist and before there is

much possibility of a high evaporation from the soil causing crusting; (5) The spring planting permits suitable sized stock to be grown in one season.

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# RELATION OF SIZE OF DECIDUOUS NURSERY STOCK TO FIELD SURVIVAL IN THE GREAT PLAINS

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As a direct result of the great emphasis that has been placed during the last five or six years on the use of deciduous trees and shrubs in reforestation, erosion control, and shelterbelt planting, nursery production of such stock in the United States has increased many-fold. Although at first relatively little was known regarding the large-scale nursery propagation of deciduous species, various practices and techniques have evolved until at the present time this kind of stock can be grown almost as successfully as coniferous trees.

OF the many questions which have arisen in connection with deciduous nursery practice, one of the most important is, "What is a plantable tree?" Although man cannot control some of the environmental factors which affect field survival, such as normality of rainfall and air and soil temperatures, he can at least grow nursery stock having characteristics which enable it successfully to withstand adverse site conditions. These characteristics can be expressed in terms of height, total weight, caliper (diameter two inches above the root collar) or top-root ratio.

This article is based on a grading experiment carried on by the U. S. Forest Service to determine the effect of size on the survival of deciduous planting stock grown for windbreak planting in the Great Plains.

## DETAILS OF EXPERIMENT

The tests were conducted in the winter of 1935-36 near Mangum, Okla., with one-year-old seedlings grown in nurseries in the west-central part of the state. Fourteen different species were involved with each represented by a sample of from five hundred to eighteen hundred trees.

The stock of each species was graded by individual trees into total height-caliper classes, most of which, for ease of analysis, usually contained from one to two hundred trees. Height was measured

from the ground line to the tip of the stem; caliper was measured at a point two inches above the ground line. Data were also obtained on top-root ratio for each species and the density (number of seedlings per lineal foot of row) at which the stock was grown in the nursery. Practically all seedlings were grown in rows from 20 to 40 inches apart and at a density of from four to ten per lineal foot of row.

After grading was completed, the trees were planted in the field. Planting was done between December 1935 and February 1936; survival counts were made in the middle of June and again at the end of October 1936.

## CLIMATIC AND SOIL CONDITIONS

The experiment was conducted under severe climatic conditions. For example, the precipitation for the first eight months of 1936 was 26 per cent of normal and, in spite of heavy rains in September, was only 55 per cent of normal on November 1. The severity of the test was also increased because of abnormal air and soil temperatures.

The seedlings were planted on two separate sites, one with soil consisting of a clay loam, the other a sandy loam. The latter consisted of a strip of land (2 miles long and 165 feet wide) 40 acres in area; the strip of clay loam (one-half mile long) had an area of 10 acres.

On both areas the soil between the tree rows was cultivated and kept free from weed growth during the growing season. No water was supplied, however, other than that furnished by precipitation.

### RESULTS WITH REGARD TO FIELD SURVIVAL

The design of the experiment made it possible to analyze survival separately by caliper, total height, and total green weight classes. Figure 1 shows the first-year survival per cents by total height-caliper classes for six species; those for the remaining eight species are omitted for the sake of brevity. Figures 2, 3, and 4 show the relation of first-year survival to caliper, total green weight, and total height for four representative species. It will be noted that in practically all cases the larger size classes show a decidedly better survival than the smaller stock, regardless of whether caliper, total height or total green weight are used as criteria. Although a few inconsistencies occurred,

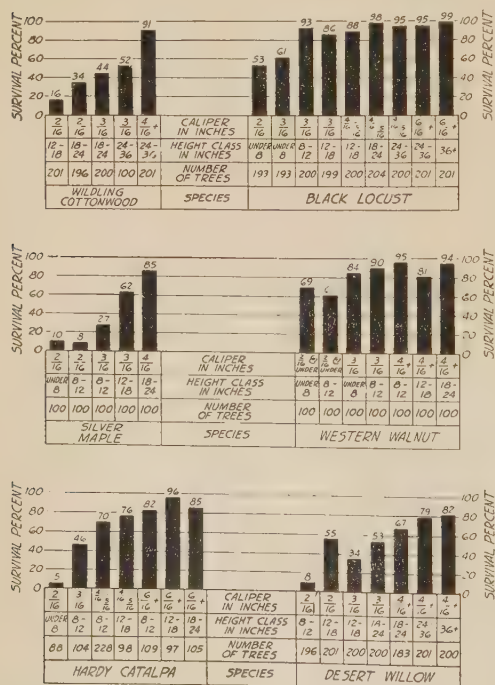


Fig. 1.—First-year field survival of deciduous nursery stock by total height-caliper classes in a drought year. Mangum, Okla., 1936.

these were largely due to slight soil differences and care after planting.

After a study was made of the survival in relation to each of the three criteria, it was decided that caliper is the most practical basis for grading deciduous nursery stock. Although total green weight provides a better technical basis, it is not as practicable as the former. Total height is also fairly satisfactory but is much inferior to caliper, especially for smaller stock, as there is always a possibility that the seedlings may have been grown too dense in the nursery and are hence tall and spindling.

The effect of density is well brought out by a study, covering several nursery series, in which it was found that seedlings in a given caliper class may be as much as 20 to 30 per cent taller than stands of 20 to 40 seedlings per lineal foot or row than in stands of 5 to 10 per lineal foot. There is a danger that crowding may produce stock which is acceptable as to height but distinctly below par as to caliper. A case in point is some of the western walnut stock represented in Figure 1. As will be observed, the 8 to 11 inch height class contains three different caliper classes, namely two-sixteenths, three-sixteenths, and four-sixteenths over, with survival per cents of 61, 95 and 95 respectively. Since the present aim of the shelterbelt planting program sponsored by the U. S. Forest Service

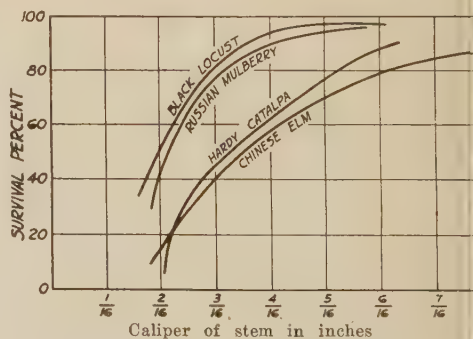


Fig. 2.—Relation of caliper of deciduous nursery stock to first-year field survival in a drought year. Mangum, Okla., 1936.

the Plains States, is an average first-year survival of at least 70 per cent for most species even in years of subnormal rainfall, it is readily apparent that only the larger caliper stock should be planted to attain this goal.

The next step in the analysis consisted of setting up grading standards. Three grades were established, namely, premium, marginal, and cull. The premium grades usually gave a first-year survival of 70 per cent or more; the marginal, from 40 to 69 per cent; and the cull, from 5 to 39 per cent. Using the survival obtained at the end of the first year as a basis, each 100-tree lot of seedlings was assigned to one of these grades.

The results have been used to build up a practical guide for grading purposes (Table 1). Although the stock at the time of planting was grouped into sixteenth-inch caliper classes, it was deemed advisable to make interpolations to thirty-seconds of an inch, as experience demonstrates that nursery workers, after a short period of training, can easily learn to estimate to the nearest thirty-second of an inch. This is especially true in the smaller grades where the tension zone between the marginal and cull grades occurs.

In setting up the minimum acceptable

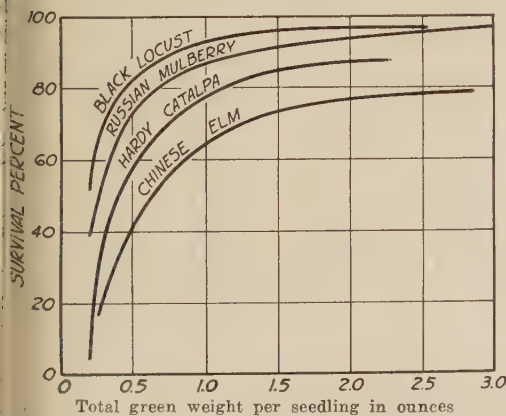


Fig. 3.—Relation of total green weight of deciduous nursery stock to first-year field survival in a drought year. Mangum, Okla., 1936.

size for the premium grade of stock, some consideration was given to the distribution of caliper classes within the premium grade. For instances, the bar chart in Figure 1 indicates that the trees of seven-thirty-seconds caliper could be expected to give only about 58 per cent survival. However, in a "field run" of stock which is graded out into trees of seven-thirty-seconds caliper or over, there will be a considerable number of trees from nine to sixteen-thirty-seconds, and these larger sizes will bring the average survival of the so-called premium grade to over 70 per cent survival.

#### TOP-ROOT RATIO RELATIVELY UNIMPORTANT

The top-root ratio measurements (green weight basis) for the various species made at the time of planting, revealed that practically all of the nursery-grown stock, except desert willow and the larger trees of Russian mulberry and Chinese elm, had a top-root ratio of less than 1.0:1 and often as low as 0.2:1. Wildling stock of cottonwood and tamarix which were "pulled" from sand bars along streams was distinctly poorer in top-root ratio than the nursery-grown stock, and generally had a top-root ratio of between 1.0:1 and 2.5:1.

Since in all cases the larger trees of a given species had the higher top-root ra-

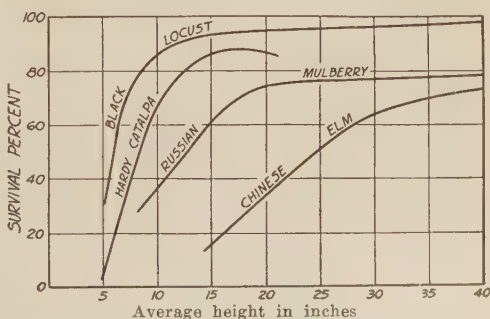


Fig. 4.—Relation of average height of deciduous nursery stock to first-year field survival in a drought year. Mangum, Okla., 1936.

tios, it was believed that such trees might show poorer field survival than medium-sized trees. This was not the case, however; the larger trees gave the best field survival. Apparently, adequacy of caliper and of total green weight are more important factors in determining field survival of deciduous nursery stock than top-root ratio. It is conceivable, of course, that stock of adequate caliper, but of very poor balance, can be produced by heavy watering of over-dense stands. However, if two simple, fundamental rules are followed in nursery practice, namely: keeping the stand at a density of 4 to 10 per lineal foot of row with rows 16 to 32 inches apart, and hardening off the stock by applying very little water after July 15, it will be practically impossible to produce stock that is seriously top-heavy or has poor root development. Limited watering after midsummer stimulates the development of a fibrous root system and reduces the chances of developing late season succulence. If the stock is very top-heavy, top pruning of

the trees may be of some benefit in obtaining better balance.

# REASONS FOR THE BETTER SURVIVAL OF LARGE STOCK

The main reason for the better survival of the larger trees was the fact that such stock had a larger reserve of stored food and was thus able to establish itself more quickly. By midsummer the larger planting stock had a wider spread of roots, and often had penetrated deep enough into the soil to tap the subsoil moisture. Roots of such seedlings at the end of the first year after field planting were found to have a spread of from 6 to 12 feet and a depth of penetration of from 2½ to 5 feet.

Another favorable factor was the greater resistance of the larger trees to drying out of their tissues by hot summer winds, to heat injury at the ground line.

It is also logical to assume that a part of the loss in the small stock was due to an inherent slowness of growth and lack of drought hardiness.

TABLE 1

DEFINITION OF GRADES OF DECIDUOUS NURSERY STOCK BASED ON FIELD SURVIVAL IN A DROUGHT YEAR, MANCUM, OKLA., 1936

Species	Premium grade		Marginal grade		Cull		
	Caliper Inches <sup>1</sup>	Total green weight per seedling Ounces	Caliper Inches	Total green weight per seedling Ounces	Caliper Inches	Total green weight per seedling Ounces	Height Inches
Osage orange	5/32+	0.4+	3/32-4/32	0.2-0.4	3/32	0.2	18
Honey locust	6/32+	0.4+	3/32-5/32	0.2-0.4	3/32	0.2	18
Green ash	6/32+	0.4+	4/32-5/32	0.2-0.4	4/32	0.2	18
Soapberry	6/32+	0.4+	4/32-5/32	0.2-0.4	4/32	0.2	18
Black locust	6/32+	0.5+	4/32-5/32	0.2-0.5	4/32	0.2	18
Western walnut	6/32+	0.5+	4/32-5/32	0.2-0.5	4/32	0.2	18
Hackberry	6/32+	0.5+	4/32-5/32	0.2-0.5	4/32	0.2	18
American elm	7/32+	0.5+	4/32-6/32	0.2-0.5	4/32	0.2	18
Russian mulberry	6/32+	0.5+	4/32-5/32	0.25-0.5	4/32	0.25	18
Desert willow	7/32+	0.5+	4/32-6/32	0.2-0.5	4/32	0.2	18
Chinese elm ( <i>Ulmus pumila</i> )	7/32+	0.8+	4/32-6/32	0.25-0.8	4/32	0.25	18
Soft maple	7/32+	0.5+	5/32-6/32	0.25-0.5	5/32	0.25	18
Catalpa	7/32+	0.5+	5/32-6/32	0.25-0.5	5/32	0.25	18
Wilding cottonwood	7/32+	0.6+	5/32-6/32	0.3-0.6	5/32	0.3	18

<sup>1</sup>The upper limit for caliper in all species in the premium grades can be set at 12 inches. Trees in excess of this size show good survival but are so large as to reduce material planting speed.

## SUMMARY AND CONCLUSIONS

1. On the basis of field survival, deciduous planting stock used in a wind-break planting near Mangum, Okla., was classified into three grades: premium, marginal, and cull. Premium stock usually gave a first-year survival of 70 per cent or better, marginal from 40 to 69 per cent, and cull from 5 to 39 per cent.

2. Relatively large stock gave the best survival.

3. Caliper or diameter of the stem two inches above the ground line was found to be the most practical index of grading stock into quality classes.

4. Stock with a caliper of six-thirty-seconds to twelve-thirty-seconds of an inch represents the best size of stock for wind break planting in the Great Plains if both survival and cost of planting are considered.

5. On the basis of caliper a general rule can be devised: Stock six-thirty-seconds of an inch or over represents the premium grade; four and five-thirty-seconds, the marginal; and under four-thirty-seconds, the cull grade. This is shown for various species in Table 1.

6. On the basis of total green weight, stock weighing over one-half and up to ten ounces represents the premium grade; two-tenths to one-half ounce, the marginal; and below two-tenths ounce, the cull grade.

7. The larger grades of stock were 50 to 80 per cent taller at the end of the first growing season than the smaller grades.

8. Grading standards must be varied somewhat by species. In general, the smaller grades of slow-growing species will give higher field survivals than the same grades in the more succulent, fast-growing species.

9. Top-root ratio was relatively unimportant in relation to field survival.

10. Nursery practice for most species of deciduous stock used for planting in the Great Plains should be so adjusted

as to obtain stands of 4 to 10 seedlings per lineal foot of row with rows 16 to 32 inches apart, although the ideal density will be governed to some extent by irrigation facilities. This range of densities will usually produce the maximum number of premium grade seedlings. In some instances it may take two or three years for some species to attain plantable size.

11. Lack of size in nursery stock may be due to an inherent lack of vigor or other hereditary defects, to a natural slowness of growth, to a lack of adequate growing conditions in the nursery, or to delayed germination.

12. In a situation where 10 to 20 per cent of a given lot of stock is in the cull class and the remainder of the stock of adequate field planting size, the culls should by all means be destroyed. They should in no case be lined out in the nursery to grow to larger size, as such stock includes many trees which are defective from a genetic viewpoint and hence should be weeded out at the nursery. Furthermore, from the economic viewpoint, it is cheaper to discard the culls and grow seedlings of adequate size from seed, as lining out is a costly operation for deciduous stock.

13. Nursery grown stock usually gave better survival than wildlings obtained from sand bars along streams.

14. Small trees of a given class planted on sandy soils subject to blowing and drifting usually showed poorer survival than trees of the same class planted on clay loam soils. This was due largely to covering of the small trees by drifting sand or by blowing away of soil from the roots. In the larger size classes, survival was about the same on both sites.

15. The data and principles here presented are probably applicable to many areas where deciduous species are planted under rather adverse moisture conditions, due either to scanty precipitation or to competing vegetation, but they apply specifically to that portion of the Great Plains between the 98th and 101st meridians.

# POLYPORUS HISPIDUS AND A CANKER OF OAKS

BY BAILEY SLEETH AND C. BRADFORD BIDWELL<sup>1</sup>

*Polyporus hispidus* has been recognized as a serious heartwood-rotting fungus for many years. Evidence is submitted that an important canker of oaks also is caused by this fungus. A study of an area in Connecticut showed that 2 per cent of the white oak, 8 per cent of the chestnut oak, and 13 per cent of the black oak had cankers. The average total loss resulting from the cankers amounted to 2 per cent of the cordwood volume and 3 per cent of the boardfoot volume. In a selected one-tenth acre plot the loss amounted to 29 per cent of the cordwood volume and 33 per cent of the boardfoot volume. Felling and, where possible, utilizing infected trees is the best method of control.

A LARGE number of cankered oak trees were observed by the Connecticut State Forest Service pathologist on the Nehantic State Forest while making a disease survey in 1934. The cankers were in some respects similar to *Strumella* cankers and could be confused with them. The appearance of sporophores of *Polyporus hispidus* (Bull.) Fr. on some of the cankers during the fall of 1935 and other characteristics eliminated the possibility of the cankers being caused by the *Strumella* fungus. Since sporophores of *P. hispidus* were frequently found associated with the cankers it seemed advisable to make a brief study of a small area in which there was a large number of cankered oak trees. The purpose of the study was to check on the relationship between *P. hispidus* and the cankers, the distribution and intensity of infection, the cull or loss from the canker and decay and to learn the distinguishing characteristics of the canker so that it could be readily recognized in a disease survey or in marking for silvicultural cuttings.

## HOSTS AND DISTRIBUTION OF *Polyporus hispidus*

For many years *Polyporus hispidus* has been recognized as a serious heartwood-rotting fungus with several host species

and of wide distribution. In 1893 Prunell (9) reported the fungus as an injurious parasite causing considerable damage to mulberry and apple trees in France. He described it as attacking the heartwood and observed that entrance was made through a cut or broken branch.

Butler (3) reported *P. hispidus* as "extremely common on mulberries and was found attacking apple, plum and apricot trees in Kashmir". He observed the fungus to be a wound parasite that entered through a broken or cut branch, and that the fungus did not enter through scars left by breaking off small twigs which had no heartwood. Entrance was made only through wounds exposing heartwood. Massee (6) considered the fungus to be a wound-parasite, "which is very injurious to fruit-trees, apple, pear, plum, etc.; it also attacks other trees, more especially the ash". Nutman (7) stated that *P. hispidus* is one of the chief fungi attacking both black ash and white ash in England and that small fructifications have been found frequently on elm. It was mentioned its being reported on walnuts by Rea and on plane by Schroeter. In Michigan, Baxter (2) found that the fungus was usually epidemic wherever it occurred on black ash and that it apparently had no other host species within the state. Graves (4) found a black

<sup>1</sup>Division of Forest Pathology, U. S. Bureau of Plant Industry and the Connecticut Forest Service. Study supported in part by Emergency Conservation Work.—Co-authors.

(*Q. velutina*) with several elongated cankers bearing fruiting bodies of *P. hispidus* in a forest on Staten Island. Unusual as it may seem this was the only reference found in literature that reported the occurrence of sporophores of *P. hispidus* on cankers of oaks. However, the two have been commonly observed in recent years on oaks by forest pathologists in the eastern United States.

One might question the identity of the fungus reported above because of its host relationship. In India and France it apparently causes severe damage to fruit trees; in England it attacks both black ash and white ash; in Michigan it has been reported only on black ash; in the eastern United States it has been found only on oaks and usually in association with cankers. If the fungus in all cases

reported is the same species there is little doubt that physiologic differentiation occurs within the species and perhaps certain forms may be confined to certain geographic regions.

#### THE CANKER

The canker has been briefly described (4) as occurring in a considerably hypertrophied region of the tree's trunk, thus forming a spindle-shaped swelling in the bole. This holds true in general for the affected oak trees. Typical cankers found on the oaks in the Nehantic Forest were characterized by the elongated, swollen region with a bark-covered, sunken area bordered by one or more folds of callus over-growth (Fig. 1). Near the center of the canker was found the remnant of



Fig. 1.—*Polyporus hispidus* cankers on oak. A.—Sporophore of *P. hispidus* and canker on a chestnut oak. (Photographed by L. O. Overholts.) B.—A much elongated canker on a black oak. C.—A small suppressed chestnut oak. Note the bark on the face of the cankers and the bordering callus folds.

an old branch scar which served as the point of entry for the fungus (Fig. 2). During the sporophore-bearing season the cankers usually may be identified by the presence of one or more sporophores of *P. hispidus* on the face of the cankers. The sporophore is easily recognized and has been described (8) as a large, thick, sessile, spongy, hirsute species and brown throughout. Sporophores range in size from 2.9 x 4.10 x 1.2 inches. Sporophore

production varies from year to year and with individual trees. Also the period during which the fruiting body remains attached to the canker may differ greatly with the locality and weather conditions. In the Nehantic area this period in 1935 was of short duration, while in West Virginia old fruiting bodies were observed attached to cankered trees as late as June 1936.

There has been speculation and some



Fig. 2.—A-B. Longitudinal sections through a *Polyporus hispidus* canker on a 13-inch d.b.h. black oak. In B note old branch stub in center of canker through which fungus entered. C—Cross sections from the middle region of a 12-foot canker on black oak. The fungus has decayed all the heartwood and has killed a sizable area of sapwood and cambium which forms the face of the canker.

disagreement on the relationship between the above-described canker on oaks and *P. hispidus*. The authors, on the basis of association and lack of proof to the contrary, regard the fungus as the primary causal agent of the canker. It is realized that further investigation may prove otherwise and that production of cankers by polypores is considered unusual. Since the cankers are commonly called *Hispidus* cankers they will be so termed in this paper.

An important difference between the *Hispidus* and the *Strumella* cankers is the manner in which the live tissues of the trees are invaded by the respective pathogens. After gaining entrance through a dead branch stub and becoming well-established in the heartwood, *P. hispidus* attacks the living cells of the inner sapwood near the point of entry. The fungus gradually works outward killing the living wood and eventually the cambium and bark. The *Strumella*-canker organism attacks the live tissue in the cambium region and apparently is more of an active parasite than *P. hispidus*. In brief, *P. hispidus* attacks from the inside outward, meanwhile producing a typical rot in the invaded wood, while the *Strumella* works mainly on the outer living tissue and apparently causes no extensive decay.

Identification of the fungi found in the dissected cankers was made by culturing material from the advanced and incipient decay. The culturing and identification were done by R. W. Davidson and Dorothy Blaisdell of the Division of Forest Pathology, Washington, D. C. It is believed that the cultural method of identifying decay-causing organisms has many advantages over attempting to identify the causal fungus by examination and comparison of the decayed wood.

#### PREVALENCE AND DAMAGE

All cankered trees on a half-acre plot were felled and carefully examined. Data

on the cankers and decay were taken and specimens for culturing were collected. In order to get more definite information on the distribution and number of cankered trees and volume of cull per acre a 10 per cent survey was made of the area adjacent to the half-acre plot. A total of 36 tenth-acre plots were laid out at regular intervals, one plot to an acre.

*A One-Half Acre Plot Study.*—Sixteen cankered trees were cut on the one-half acre plot (approximately 104 x 210 feet) that extended from the base of a low steep-sided ridge up the side and slightly more than half-way across the top of the ridge. The sixteen trees had an average height of 48 feet, a d.b.h. of 7.4 inches, and a ring count of 64 at stump height. Ten of the cankered trees were chestnut oak (*Quercus montana*), three scarlet oak (*Q. coccinea*), two red oak (*Q. borealis*), and one white oak (*Q. alba*).

Many of the cankers had no sporophores, but most of them had traces of recent sporophore production. Cultures of *P. hispidus* were isolated from the 20 cankers appearing on the sixteen trees. One chestnut oak tree had 3 separate cankers, each the result of a separate infection. Two trees, one scarlet oak and one chestnut oak, had two cankers each, while the remaining 13 trees had one canker each.

The cankers occurred at no consistent height. The lowest canker observed on the plot was 2-7 feet high and the highest was 17-22 feet with an average of 9-13 feet. This compares closely with the results secured in the tenth-acre plot survey where the lowest canker was 0-8 feet on a 9-inch d.b.h. black oak and the highest canker was 30-35 feet on an 11-inch d.b.h. chestnut oak. The largest cankered tree observed in the survey was a 16-inch d.b.h. black oak with sporophores on a 0-15 feet spindle-shaped canker.

A fungus appearing black in culture was nearly always isolated with the cultures of *P. hispidus* obtained from the

decayed specimens taken from the cankered oaks. A few specimens taken from the region of incipient decay yielded *P. hispidus* in pure culture. This would seemingly indicate that the black fungus was not necessary for the invasion of the other. It is probable that the black fungus is of secondary importance and that it follows very closely the invasion of *P. hispidus* which is considered to be primarily responsible for the decay and canker formation, but a more intensive study which includes inoculations with pure cultures of both of these fungi will have to be made to settle this point. The identity of the black fungus was not determined.

A close relationship apparently exists between the two fungi, but it seems unlikely that the presence of both is necessary for the production of cankers. There is some evidence indicating that *P. hispidus* is the causal agent bringing about the cankerous condition of oaks herein reported. In this connection it is considered significant that *P. hispidus* was isolated free of its common associate in the region of incipient decay, and that its ability to attack sapwood has been demonstrated on ash by Baxter (2) and Nutman (7).

As in ash and apple trees, a dead branch or branch stub was found to be the point of entrance for the fungus. After gaining entrance into the heartwood, the fungus produces a white crumbly decay, which, as it grows older, becomes waxy-yellow in appearance. The prog-

ress of the fungus is more rapid longitudinally than radially in the affected tree. An elongated, semi-oval, decayed region is formed with a dead branch stub in the center (Fig. 2). The comparative average rate of fungus invasion with resulting heartwood decay was found to be about six times greater longitudinally than radially from the point of infection. Thus for each inch of radial invasion from the point of infection the fungus penetrated approximately six inches in both directions longitudinally.

By making ring counts in an attempt to get the age of the oldest callus formation, it was found that the oldest cankers had been in the process of formation for not less than 30 years in the 60-70 year old trees. This would indicate that infection took place when the trees were 30-40 years old and when the young stand was undergoing natural pruning. The dead and dying branches, resulting from such pruning, would afford an excellent means for the fungus to enter the heartwood.

*A 10 per Cent Survey.*—Oaks made up approximately 90 per cent of the stand on the area covered by the 36 tenth-acre plots. The results and calculations are based upon the number of oaks found on the 36 acres. The relative frequency of infection and the percentage of oaks infected are given in Table 1. The site quality varied from poor to very poor, because the ridges sloped abruptly to small swamps. There was no significant difference between the number of cankers

TABLE 1  
RELATIVE FREQUENCY OF *P. hispidus* CANKERED OAKS PER ACRE<sup>1</sup>

Species	Number per acre	Number infected per acre	Per cent infected per acre
White oak .....	25	0.5	2
Scarlet oak .....	25	0.7	3
Red oak .....	17	1.0	6
Chestnut oak .....	106	8.0	8
Black oak .....	22	3.0	13
Total .....	195	13.2	7

<sup>1</sup>Based upon a 10 per cent survey of 36 acres and one one-half acre plot.

on the poor and very poor sites. Cankered trees were observed on medium to good sites in other areas. Apparently site quality is not an important factor in infection intensity. Vigorous trees in the dominant and codominant classes were attacked as frequently as the less thrifty individuals in the intermediate and suppressed classes.

The heights at which cankers were observed varied from ground level to 35 feet. However, 68 per cent occurred in the first 12 feet and 90 per cent below 20 feet, so that the resulting loss would be in the best quality logs. The average length of the cankers was 3.2 feet with extremes of 1 foot and 15 feet. Based on the dissection of 25 cankered trees, the average extent of the advanced and incipient decay beyond the canker was 1.2 feet. The decay extended only for the length of the canker in 28 per cent of the cases and 60 per cent fell within the 1.2 feet limit. In two trees the decay extended over 3 feet beyond the canker extremities. Although no general statement on cull can be made from these figures, it is considered justifiable to make an allowance of 1 foot below and 1 foot above the canker in figuring the loss in volume due to decay in this area.

No significant relation between diameter breast-high and the extent of decay beyond the canker was found. The discoloration or incipient decay extended approximately one foot beyond the actual

presence of the fungus hyphae in the wood as determined by laboratory cultural isolations from sample blocks taken at foot intervals. This is important in that no additional allowance for a hidden stage of incipient decay need be made in figuring cull in oaks.

A portion of the 60-80 year old stand covering the 36 acre area had been cut over for ties 15 years before this study was made. On the poor sites an average of 36 trees per acre had been cut, but very few trees had been cut on the half of the area comprised of the very poor sites. However, the intensity of cankering seemed to vary with the distance from the highest intensity of infection, rather than from any difference in the number of trees cut in the past. In the survey only 22 of the 36 plots had *Hispidus*-cankered trees, although cankered trees were observed near the 14 non-infected plots. Cankered trees were found singly and in small groups in a brief reconnaissance of the surrounding area, although not in as great numbers as in the area cruised.

*Damage to the Stand.*—As the percentage of trees infected does not give a true picture of the actual loss caused by the cankers and decay, the cull in cords and board feet was figured for the area. The average gross volume, average cull volume per acre, and percentage of cull are given for the 36 acres and for the area of heaviest infection in Table 2.

TABLE 2  
LOSS IN VOLUME OF A 36-ACRE STAND DUE TO *P. hispidus*<sup>1</sup>

Acres basis	Average volume per acre					
	Gross	Cull	Cull	Gross <sup>4</sup>	Cull	Cull
Number	Cords	Cords	Per cent	Bd. ft.	Bd. ft.	Per cent
36	14.4	0.3	2	3850	110	3
22 <sup>2</sup>	14.9	0.4	3	3810	180	5
0.1 <sup>3</sup>	29.5	8.6	29	11850	4000	33

<sup>1</sup>Tables by Hawley and Wheaton (5), pp. 13, 36, and 39, used to calculate volume. From data on each cankered tree, the cull in cubic feet and board feet was scaled from taper curves for each diameter class.

<sup>2</sup>At least one canker was found on each plot.

<sup>3</sup>A one-tenth acre plot selected for largest number of cankers.

<sup>4</sup>Trees 8 inches d.b.h. and over.

The total loss per acre for the entire 36 acres was 2 per cent in terms of cord wood and 3 per cent in board feet, while on the basis of the 22 acres where at least one cankered tree was found on a tenth-acre plot, the loss was slightly higher. In certain localized areas the loss per acre was high. One one-tenth-acre plot with a large number of cankers had a loss of 29 per cent in cord wood and 33 per cent in board feet.

Cankered trees may break over and cause considerable damage to a stand. The decaying of the heartwood so weakens the tree that snow, sleet and wind storms will in the course of a rotation break over many cankered trees. Unless such trees were utilized soon after breaking over, the damage or loss to a stand would likely be higher than if no breaking had occurred, since the trees would become a total loss. Such was the case in the Nehantic area where a number of broken-over trees were found.

#### CONTROL

The control of *Polyporus hispidus* and associated cankers in oaks can best be secured by felling the affected trees and utilizing them if possible. In areas where a general canker (*Nectria* and *Strumella*) control program is being carried out *Hispidus* cankers should be removed. It is in areas with a high percentage of infection, as in the Nehantic Forest, that special measures should be taken to eliminate the cankers.

#### SUMMARY

A study was made of an area in Connecticut on which a large number of cankered oaks were found. The presence of sporophores of the heart-rotting fungus *P. hispidus* on many of the cankers and other characteristics distinguished them from the common *Strumella* cankers. The fungus has been found on black ash in Michigan, but only on oaks in the east-

ern United States, and usually in association with cankers. Typical cankers are characterized by an elongated, swollen region with a bark-covered, sunken area bordered by one or more folds of callus over-growth. On the basis of association and lack of proof to the contrary, the authors regard the fungus as the primary causal agent of the canker, although further investigation may prove otherwise.

All cankered trees on a half-acre plot were felled, detailed data taken, and specimens of the advanced and incipient decay collected for cultural identification. Twenty cankers were found on the sixteen infected trees. The fungus entered the heartwood through a dead branch or branch stub and then produced an elongated, semi-oval region of white crumbly decay, which became waxy yellow with age. Longitudinal penetration of the decay was about six times greater than the radial. From ring counts of the earliest callus formation, it was found that the oldest cankers had been in the process of formation over 30 years in the 60-70 year old trees examined.

A 10 per cent survey was made of the 36 acres adjacent to the half-acre plot, using one tenth-acre plot to an acre spaced at regular intervals. The relative frequency of cankered oaks varied from 2 per cent for white oak to 8 and 13 per cent for chestnut and black oak. Of the average of 195 oaks per acre (the oaks made up 90 per cent of the stand) 13, or 7 per cent, were cankered. Although site quality varied from poor to very poor on the area, observations on other areas indicated that neither site quality nor vigor of the trees was an important factor in infection intensity.

Cankers were observed from ground level to a height of 35 feet. Since 90 per cent of the cankers occurred within the first 20 feet, the resulting loss in board feet would be in the logs of greatest volume and best quality. Cankers ranged from 1 to 14 feet in length with

an average of 3.2 feet. Based on the dissection of 25 cankered trees, the average extent of the advanced and incipient decay beyond the canker was 1.2 feet with 60 per cent of the cases falling within this limit. Although no general statement on cull can be made from these data, an allowance of 1 foot below and above the canker was used to figure the loss in volume on this area. It is important that the discoloration or incipient decay extended approximately one foot beyond the actual presence of the fungus hyphae in the wood, as determined by the laboratory cultural isolation. The total loss per acre for the entire 36 acres was 2 per cent of the cordwood volume and 3 per cent of the volume in board feet. A selected one-tenth acre plot with a large number of cankers had a loss of 29 per cent in cordwood and 33 per cent in board feet. Additional loss will result from breakage, due to the decaying of the heartwood and portions of the sapwood.

Felling and utilization where possible is the best method of control. In small scattered areas with a high percentage of infection, a special effort should be made to eliminate the cankered trees to prevent the future stand from becoming heavily cankered.

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## BRIEFER ARTICLES AND NOTES

### SOUTHERN PINE PULPWOOD INDUSTRY ADOPTS CONSERVATION POLICIES

The pine pulpwood industry in the South, currently in the process of great expansion, took a long step forward in the field of conservation at a meeting held in New Orleans on May 3, 1937. Representatives of all southern mills using pine pulpwood met to discuss conservation policies that must be followed to insure permanence to their industry. Major R. H. Spessard, President of the American Pulpwood Association presided, while members of the U. S. Forest Service from Washington, Atlanta, and New Orleans, and the state foresters of South Carolina, Florida, Alabama, Mississippi, Louisiana, Texas, and Arkansas took part in the discussions. The following statements of policy were adopted, of which the first is of particular interest to foresters and other conservationists:

1. It is agreed that all land, including noncompany land must be cutover in a manner which will maintain and build up the forest growing stock.

2. It is agreed that each pulpmill operator will employ the necessary qualified personnel to insure proper compliance with agreement No. 1.

3. It is agreed that the southern pulpwood consumers shall be divided into working groups for the purpose of preparing proper regional rules of forest practice.

4. It is agreed that a working committee shall be appointed for each regional group in cooperation with federal and state agencies to formulate and place into effect the cutting procedure for each

group in order to carry out agreement No. 1.

5. It is agreed to satisfy to the fullest practicable extent the requirements of each mill from improvement cuttings, worked out turpentine timber, and salvage from sawtimber cuttings.

6. The industry recognizes that federal and state forest-fire protective organizations, as now constituted, are inadequate, and urges their extension and pledges the industry's cooperation in securing more effective forest-fire control.

7. The industry agrees to secure insofar as possible the full compliance of its wood producers with the procedure of forest practice as established for each group.

In accordance with agreement No. 3, four groups were designated, as follows: (1) Tennessee, W. Virginia, Maryland, Virginia, and North Carolina; (2) South Carolina, Georgia, and northeast Florida; (3) west Florida, Alabama, Mississippi, and southeast Louisiana; (4) Louisiana west of the Mississippi River, Texas, and Arkansas. These four groups are actively engaged in working out and adopting local rules for various conservation activities, of which the most controversial item is undoubtedly that concerning cutting practices.

This action on the part of the pulpwood industry at this time is reassuring to the future of the South. The industry is to be congratulated upon its recognition of the need for formulating and adopting sound timber-conservation policies and upon its initiative in taking prompt and specific action. The details and success of the cutting rules adopted by the four

groups of southern pulpwood mills will be followed with great interest by foresters and others interested in the permanent production of wealth from the vast timberlands of the South.



#### AN OLD MENSURATION BOOK

"A Complete Treatise on the Mensuration of Timber—containing besides all the rules usually given—etc. etc." is the title of an early American mensuration book, in the library of the U. S. Forest Service at Washington. It was published in 1805, at Troy, N. Y.; "Printed by Wright, Wilbur, and Stockwell for themselves and the author," the latter being one James Thompson.

On the reverse side of the title page are two interesting items. One has to do with the copyright of the book. According to the Encyclopedia Britannica the first copyright statute in this country was enacted by Congress in 1790. The statute provided for the deposit, before publication, of a printed title page in the clerk's office of the local U. S. district court. This original act was followed by the act of 1802 which required the record of copyright to be printed on or following the title page.

The latter law accounts for the first of the two items, which reads:

#### COPY RIGHT

##### DISTRICT OF NEW-YORK, SS

(L. S.) Be it remembered, that on the eighth day of October, in the twenty-ninth year of the Independence of the United States of America, *James Thompson*, of the said District, hath deposited in this Office the title of a book, the right whereof he claims as author, in the words following, to wit:

"A complete treatise on the mensuration of timber—Containing, besides all the rules usually given on the subject,

some new and interesting improvements, particularly the new, expeditious, and very accurate method of calculating the contents of square and round timber. . . . With the description of the sliding rule and Gunter's scale, so far as they relate to this art. The whole being illustrated with examples at full length, and is well adapted to the practical timber measurer.

"BY JAMES THOMPSON."

In conformity to the act of the congress of the United States, entitled "An act for the encouragement of learning, by securing the copies of maps, charts, and books, to the authors and proprietors of such copies, during the time therein mentioned."

Edward Dunscomb,

Clerk of the District  
of New-York

The lengthy title takes almost as much space as does all the legal language surrounding it.

Below the copyright record, a small hand points to this self explanatory paragraph:

"In order to prevent the Publick from being imposed upon, by any spurious imitations of the following Treatise, or of the Tables contained therein—I have thought proper to distinguish such copies as are correct and genuine, by subscribing my name."

Affixed is James Thompson's autograph done in ink which ran through the paper and is visible on the title page.

The preface states that the book is an attempt to explain the practical rules for the mensuration of timber "in an easy, obvious manner—so that they may be sufficiently intelligible for common practice, even to those who have not had the advantage of a mathematical education." To this end "the application of decimal arithmetick in all its parts", is treated of, "together with the extraction of the square and cube roots, as fully as is needful," "Decimal Tables," giving inches as deci-

mals of a foot, pints as decimals of a gallon, and ounces as decimals of a pound, indicate that the urge for a more rational system of weights and measures in this country is almost as old as the country itself. The rules for extracting square root and cube root are set to verse, for easy memorizing. The rule for the square root runs thus:

"The root of your first period you  
Must place in quote, if you work true:  
Whose square from your said period  
then

You must subduct; and to th' remain  
Another period being brought,  
You must divide as here is taught,  
By the double of your quote, but see  
Your unit's place you do leave free;  
Which place will be supply'd by th'  
square

Of your next quoted figure there;  
Next multiply, subduct, and then  
Repeat your work unto the end;  
And if your number be irrational,  
Add pairs of cyphers for a decimal."

In a section on "Instrumental Arithmetick" is explained the use of Gunter's scale and the sliding rule. Gunter's scale is evidently a single line divided logarithmically. A pair of compasses is used to measure off distances, and make the mechanical computation. After a description of the sliding rule, there follows this paragraph:

"On the under side of the slider (on the sliding rule) is another line, marked the *girt line*, and is useful in casting up solids. Besides, at divisions 17.15 and 18.95, are marked W.G. and A.G. the wine and ale gauge points, for the purpose of gauging wine and ale thereby."

The part on "Mensuration, etc." begins near the center of the book. The first problem is to find the superficial content of a board or plank, whose width is equal from end to end; the second, to do the same for a tapering board. Then follows the rule for contents of squared timbers in board measure, and finally, rules

for finding the solid contents of round timbers. For tapering logs this rule is given: "To the product of the girts of the two bases or ends, add  $\frac{1}{3}$  the square of the difference, the sum will be the square of the mean girt, which multiply by .0795775, the product will be the mean area; this multiplied by the length, gives the solid content." An interesting footnote is appended: "Round trees tapering to points are cones, and their contents are found by multiplying the area of the base by  $\frac{1}{3}$  the length. Any round tree tapering to a point is equal to  $\frac{1}{3}$  part of a round log of the same base and length. Tapering round logs or trees, with the points cut off, are frustums of cones."

A table which follows entitled "A table of the contents of cylinders reduced to cubick feet and decimal parts, for all circumferences or girts, from 10 to 141 inches, and for 1 foot in length," may be the first basal area table published in this country. The use of this table is explained and illustrated, and then the treatise is brought to a close with a few pages of practical exercises.

The book measures 4 by 6 inches and contains 87 pages. Its front cover has been replaced, but the back cover is apparently the original one. As though to make the book still more interesting to foresters, this back cover is made of a thin piece of wood, perhaps chestnut, which shows through, where the decorated paper pasted over it has worn off.

J. H. BUELL,  
*Appalachian Forest  
Experiment Station.*



#### TIE CUTTING ON THE LARAMIE RIVER WORKING CIRCLE

The Laramie River Working Circle occupies the northwestern corner of the Roosevelt National Forest. Comprising the drainage of the Laramie River in

Colorado, its natural outlet is north to Laramie.

Ever since the construction of the Union Pacific, the Medicine Bow Mountains and other timber adjacent to Laramie have supplied a large part of its cross ties. During and after the World War, several operators were producing ties from timberland traversed by the Laramie, North Park and Western Railroad. Because of crowding and consequent jeopardizing of sustained yield on this railroad working circle, the Otto Lumber Company commenced operations on the Laramie River Circle in 1926. It had cut over one logging unit on the Roosevelt (East Beaver Creek) before reaching this circle, then began on the northernmost unit and are now working southward on the west side of the river and on the east slope of the Medicine Bow range.

At present the company is operating in the Stuck Creek unit. A total of 113,685 ties had been removed to November 30, 1936. Both hewed and sawed ties are produced.

The actual hewing process is the same as when the first tie was made in the mountains of western America. Trees of suitable size are trimmed as far up as ties can be made (9½ inches at the small end of the 8-foot cut). An experienced man in good timber may turn out from 15 to 20 ties a day. About one-third are No. 1 ties, which must be 7 inches thick with an 8-inch face, and for which the "tie hack" receives 29 cents. However, such practices as long butting large trees in order to secure logs of easier size for hewing have gone the way of other wasteful pioneer methods. Instead, all trees and portions of trees not suitable for hewing, but otherwise suitable for ties, are cut into logs for the sawmill.

The sawing of ties in a portable mill was introduced about twelve years ago and has increased rapidly. It utilizes logs

too large for hewing and also offers a means of rapidly manufacturing small, rough logs. The future tendency will be toward sawed ties altogether. From the railroad's point of view, they offer several advantages. Their uniform size permits even and thorough treatment. The volume of creosote required for the desired penetration can be computed in advance, which cannot be done with hewed ties. A further disadvantage of the hewed tie is that it is prone to absorb more creosote on the two round sides, as they contain more sapwood. In replacing ties in the track, it is an advantage if the new tie has the same dimensions as the old.

Approximately 40 per cent of the ties produced by the Otto Lumber Company have been sawed. At present, the ratio of sawed ties has increased to one-half and bids fair to increase still more. The company maintains two portable sawmills. These mills and those owned by other operators in the vicinity differ in minor details only. The typical outfit consists of an American portable mill.

The mill crew proper consists of four men, but ten may be needed to manufacture ties efficiently. These are a sawyer, log turner, two offbearers, a man to peel ties slabbed on two slides, and five teamsters to bring the logs to the deck. The general practice in sawing is to slab heavily, but some side lumber is produced. When conditions are favorable, a mill is capable of turning out 500 ties a day, but this is by no means an average figure. The mills are highly mobile and move frequently. Probably the average number of ties sawed at one setting is about 1,000, but it varies from 300 to 3,000. Logs are not skidded more than ⅛ mile.

Stumpage prices for sawlogs vary. Logs suitable for hewing are charged for at the same piece rate as hewed ties, 10 cents. These are 9 to 14 inches in diameter at the small end, free from defects, and

reasonably straight and smooth. Other logs cost \$1 per thousand. In order to avoid scaling every log, the sawed ties are counted and stamped when a setting is completed. Samples of 100 logs are taken during sawing, from which are obtained the percentage of ties sawed from logs suitable for hewing and the percentage from sawlogs and the average log scale of the latter.

Getting the ties to market is fully as important as making them. The Laramie River provides a ready method of transportation. Most of the ties are now cut about ten miles from the river. Modern, mechanized methods are used by the company to transport the ties over this distance. Roads are constructed in the woods at convenient intervals by a Diesel "40" tractor and bulldozer. Every sawmill setting is reached by one of these roads. Sawed ties are loaded directly upon motor trucks. Hewed ties are skidded out to the roads.

Utilization seems poor after a glimpse of the 9-inch tops left in the woods. However, there is now no market for mine props or other small material, and the Union Pacific will not accept No. 3 ties. Alpine fir is not taken at all and other species to only 11 inches d.b.h. In consequence, many inferior individuals and trees of inferior species are left. The habits of lodgepole pine and the discovery of bits of charred material in the soil indicate that the extensive stands of this species owe their origin, at least in part, to the effects of partial cutting and protection from fire, particularly in the canyons and on north slopes. Not only alpine fir, but also Engelmann spruce, is a problem. The spruce is now cut for ties, but not over 10 per cent of the ties accepted by the railroad may be spruce.

Wherever the timber is opened up sufficiently, excellent lodgepole reproduction comes in. Since a large part of the old stand is of tie size, much of the area will come in to a fair stand of pine.

Through this working circle the forest supplies a number of important economic services. In addition to the ties furnished, it helps support local industry and local population on a permanent basis. It supplies local needs for rough lumber and timbers, fence posts, and fuel. It regulates streamflow and furnishes water for irrigation and recreation, and preserves scenery, which attracts recreational visitors.

A. G. RANDALL,  
*Washakie National Forest.*



#### MORTISING CHAINS FOR GIRDLING

Contrary to the statement made by J. B. Cuno in a recent note, "Chain Saw for Girdling" (*Jour. For.* 35: 503, 1937) the girdling tool designed by Ellwood Wilson was not found to be entirely satisfactory in some preliminary tests made last summer at this Station. Girdling with one kerf usually was satisfactory only in killing poplar; other tree species such as white birch, pin cherry, red maple, balsam fir, and white pine, overgrew the kerf within one season and two or more kerfs are probably necessary for killing trees of these species. This is, of course, more time consuming and makes the operation more expensive. However, with this saw as a model, a new girdling tool was devised in consultation with W. J. LeClair, formerly of the Forest Products Laboratories of Canada. It is made up of a piece of mortising chain 2½ feet long and 1 inch wide. The chain consists of a series of links very similar to those of a bicycle chain, and having several small chisels at each link. The piece is assembled so that the teeth on each side of the center run away from the center, and with a handle attached to each end. The mortising chain for this purpose was obtained from a firm in England manufacturing such chains and assembled in the

way indicated. The handles were attached here. This tool is far more satisfactory than a chain saw for girdling in that it produces a kerf wide enough not to be overgrown by any of the tree species mentioned, with one operation. It is easier to work with because one half of the chain goes idle with each pull of the handles. During the tests here it was found that it would be desirable to have special handles made for this tool, more rigidly attached to the chain than it is possible with the present construction of the chain. This could possibly be accomplished by a special link for this purpose at each end of the chain. The chain is rather expensive but the quality of the material is so high that it probably will pay in the long run, by better wear. The tests made with this tool indicate thus far that it will be decidedly more advantageous to develop a practical girdling tool based on a mortising chain than on a chain saw.

C. HEIMBURGER,

*Petawawa Forest Experiment Station.*



#### NOTES ON TALL TREES: REDWOOD VS. DOUGLAS FIR

"The tallest trees are all gone, and gone forever. Their records are mere shadows from the light of legend. That trees may have existed taller than any now living seems altogether likely as evidenced by decayed remains, but no human miracle can ever bring about their likeness again. In speaking of the Australian eucalypts, Hardy writes in "The Sun Tree Book," "And yet those other trees vanished half a century ago are ghostly shapes in the Forest of Might-Have-Been".

Claims in regard to the Douglas fir of Vancouver, said to have been 417 feet high and felled in 1895, have not been substantiated, and it must be admitted that direct evidence of its existence cannot be found. A letter received from a Van-

couver architect seems to deliver the solar plexus blow to the legend. It will be recalled that this tree was said to have been felled by a George Carey and that the data emanated from him. (See footnote on page 908, Jour. For. 33: 1935.) Listen to this: "I lived with G. Carey—having a room in his house for one or two years in early days here—thought he was up north, but if he ever turned up again I would see him and find out if there was anything in the yarn. I saw Mr. Carey's name as having attended a civic banquet given to those who were here in 1886 when the town was burned out and . . . called on him and discussed the big tree yarn. Naturally he did not recognize me after 20 years or more. He remembers he was here in 1885. Carey was a contractor, inspector for foreign lumber shipments, etc., and said, most positively, that he did not cut down any such tree as he was not a logger or in logging business, never heard of a tree of such a size either before or after the fire (1886), had heard his name had been connected with such a yarn but had not bothered to deny through the press, and had never heard of any other George Cary or Carey, but did know a Pat Cary (so did I; he kept a hotel), was sure there was no other Carey in the city in those days who had anything to do with logging or lumber. Only large tree he said was talked about was the one that obtained publicity as a section of butt was photographed as a real estate office. (A 1936 newspaper cut showing the butt as an improvised office was enclosed in the letter together with a map showing where it grew.) This place was what is now about the center of business, being near the corner of George and Granville Streets. This tree was felled by burning—so says Mr. Carey—14 feet 6 inches where burned through. Carey says he measured this himself. He also said that when clearing by the C. P. Railroad started they had to leave this tree as there was not a saw long enough

to make the cut until saws had come up from Frisco."

It looks as though California held the stakes on big trees even in those early days!

Of course this does not prove that the 417 foot tree never existed, and unfortunately the height of the 141½-foot "real estate" tree is unknown, it may have been the tree in question; but since it definitely establishes error in the records as to the original source of the information it places the data in extremely questionable status. Moreover, the architect quoted adds in a subsequent letter of May 19, 1937—"I have since had several conversations with pioneers—and none could recall any such tree in this district." California may safely lay claim to the tallest known tree of authentic measurement in the world, now or ever, in its 364 foot redwood!

HARRY D. TIEMANN,  
*Forest Products Laboratory.*



#### LOCUST BORER AND DROUGHT

During the summer of 1936 the writer had an opportunity to make several consecutive examinations of a great number of dying locust trees in the vicinity of Carlisle, Cumberland County, Pa. All indications pointed to extreme local drought in May combined with an abundance of locust borers as responsible for the death of these trees. Attention was first attracted to the trees by the large amount of boring dust conspicuous on the lower trunks—even on the larger stems, those 6 to 18 inches in diameter, which ordinarily are seldom attacked by the borer. It has been the general opinion heretofore that the trunks of trees over 5 inches d.b.h. are rarely infested because of some factors which prevent the development of the larvae.

By the latter part of June and early in July many trees showed numerous dead branches, and others were completely dead halfway down the trunk. By the middle of August, in places, 10 to 50 per cent of the roadside trees were killed to the ground and two groves approximately one-fourth and one-half acre in extent, respectively, showed similar mortality. These same trees have been observed for many years, and previous to 1936 they had appeared to be notably free from serious borer damage. As a matter of fact, previous comments of the writer had indicated that through this particular section locust suffered but little from borer damage.

Weather records taken at Carlisle, Pa., about 4 miles away from the point of greatest injury were furnished by Charles C. Hill. The total rainfall during April 1936 was a few tenths of an inch above normal, but during the last week of April and through the entire month of May the rainfall was only 1½ inches, the deficiency being nearly 2 inches. That this deficiency was even more marked in the vicinity of these locust groves is amply indicated by fading foliage on hardwood shrubs growing near the locust trees. In the middle of June privet, elder, and lilac bushes showed withered, curled foliage, clearly demonstrating the effects of the extreme drought occurring during the previous few weeks.

There seems little question that the unusual drought at the time the young larvae of the locust borer began their spring activity and while they were penetrating the bark was responsible for a very high survival of these larvae and their subsequent successful development beneath the bark of the trees. Past observations have frequently indicated a similar relationship with other borers, such as the two-lined chestnut borer and the hemlock borer. In the case of the locust borer it had been suspected but not very well confirmed. The complete destruction

of several locust plantations along the Pennsylvania Railroad right-of-way near Lancaster, Pa., was observed in 1910-12 following the marked drought of 1909 and 1910. Prior to 1910 injury was scarcely noticeable. R. C. Hall reported that in Indiana in 1930 the locust borer severely damaged a stand which before the drought of that year was uninjured. Our recent experimental work with this insect has been carried on in eastern Ohio under the direction of Dr. Hall. In 1935 apparatus was erected to test this factor experimentally by withholding moisture to groups of trees on "spoil banks."

Locust has been considered a drought-resistant tree. These observations and others where no borers were involved, which were called to the writer's attention during the droughts of 1930-36, would seem to indicate the opposite, and even suggest that lack of moisture may be one of the most important factors predisposing this tree to locust borer injury.

Information about similar injury following drought will be appreciated by this office.

F. C. CRAIGHEAD,  
*Bureau of Entomology and  
Plant Quarantine.*



## REVIEWS



**Forstlicher Naturschutz und Naturschutz im nationalen Lebensraume Deutschlands.** By A. Vietinghoff-Riesch. *Zeitschr. f. Weltforstwirtschaft.* 3:868-885. 1936.

The German idea of nature protection has of late been expressed in many forms, long and short, good and not so good, technical and philosophical. No one, I think has captured its essence in so brief and satisfactory a form as has Baron Vietinghoff in the present essay. In it he presents an historical summary of the German attitude toward land-crops from the beginnings of forestry to the present day.

Forest crops form the framework of his picture, but each stage of forestry is interpreted in terms of the agriculture and wildlife management which accompanied it. The recent stage is further illumined by some bold descriptive strokes in current architecture, city planning, reclamation, and landscaping.

The trend of Vietinghoff's ideas may perhaps be deduced from the following translation of his summary on parks, reservations, and landscape aesthetics:

"By and large, the invasion of the landscape by artificiality has become so great that there is little point in reserving and protecting little pieces of landscape here and there, while around each of them a thoughtless and reckless exploitation continues to take place. To these oases every nature-lover makes a pilgrimage, with the resulting danger that each becomes a tourist resort, with scarcely more character than any ordinary castle, tower, or hotel.

"The creation of nature reservations, small as well as large, is important and unavoidable, but each can fulfil its purpose only when divested of the atmosphere of a museum. It is much to be wished that a well-distributed system of natural spots be incorporated into every forest, in each of which the forest can develop without hindrance toward its climax, and in each of which all technical interference is excluded or reduced to a minimum. But these natural spots can attain their full significance only when they stand in biological unity with their surroundings, rather than in contrast to them.

"As with the forest, so with the German landscape in its entirety. It is not necessary that artificial modifications of the landscape discontinue. It is necessary that the whole process of landscape-modification occur in a planwise manner, and that every individual invasion be grounded upon a common architectural idea. We need not call a halt upon our gigantic task of landscape-conversion,—we need only to incorporate in it a higher cultural idea of the relation of people to land."

This is an expression of discontent, by a conservationist, with the landscape of the world's leading exemplar of conservation: Germany. We may deduce that in the long run the question of "how" is even more important than the question of "whether".

This discontent arises mainly from the lack of unity of idea between the German islands or reservations devoted to conservation of the naturalistic type, and the surrounding matrix dominated by conservation of the engineering type. How much

greater the disparity between our American islands (forests and parks), and the surrounding matrix dominated by exploitation!

ALDO LEOPOLD,  
*University of Wisconsin.*



**Yield, Stand, and Volume Tables for Even-aged Upland Oak Forests.**

By G. Luther Schnur. *U. S. Dept. Agric. Tech. Bull. 560. 87 pp., 22 figs. 1937. Price 10c.*

Although numerous volume and yield tables are available for the upland oak forests of the eastern United States, this contribution by the Forest Service is a welcome one because few of the other agencies were in a position to deal with the region as a whole. The present study, originally a joint project of three experiment stations (Allegheny, Appalachian, and Central States) has after ten years been completed by the Allegheny Station.

The difficulty in dealing with mixed hardwoods is that even-aged stands are hard to find. This problem was nicely taken care of by confining most of the plots to sites which had been charcoaled in the past 100 years. Stands were considered even-aged if the dominant trees did not vary in age by more than eight years. Why this figure was adopted is not made clear. Characteristic of most second-growth hardwood stands, a large percentage of the stems were of sprout origin.

The composition of the 409 plots was quite diversified. Fifteen species of oak and 50 associated species were represented, but red, rock, scarlet, black, and white oaks made up 83 per cent of the basal area. The data were worked up by the method described by Bruce and Reineke. It was necessary, however, to digress slightly in several cases to fit

peculiarities of the problem. In some instances a rather unique technique was employed which is well worth studying.

The results show that the mean annual growth for average sites reaches its climax of 47 cubic feet or 0.55 cords at 50 years. This figure is low in comparison with some conifer stands, but it is maintained up until about 100 years.

The volume table data consisted of measurements of some 6,000 trees. Results are presented in both cubic feet and board feet for each of five main species and seven minor species. Up to this time satisfactory volume tables either did not exist or were not available. Tables for one species were based upon a different log rule or upon different limits of utilization than those for other species. The present tables remove that difficulty. The bulletin shows able handling of a difficult problem. Undoubtedly the data will be of no little aid in future forest planning in the region.

HENRY H. CHISMAN,  
*Pa. State Forest School.*



**The Colorado Forester, National Park Service Edition.** Pub. by the Forestry Club of the Department of Forestry, Colorado State College. 128 pp. *Illus. Fort Collins, Colo. 1937.*

This edition of the *Colorado Forester*, dedicated to Arno B. Cammerer, Director of the National Park Service, endeavors to bring to the practitioner the policies, problems, and history of the National Parks. It gives the best typical cross section of the National Park Service that has ever been presented in a forest school annual.

The various administrative and recreational problems of ten of our National Parks are presented in an interesting form and the detailed information describes

many points of interest found in these Parks. The *Forester* pays a glowing tribute to Roger W. Toll, former Superintendent of Yellowstone. The publication contains many excellent photographs of scenes in our National Parks, each illustrating some interesting or outstanding point.

For the student or forester in the field who is unfamiliar with the policies and administrative problems of the National Park Service, this edition of the *Forester* presents for the first time a bird's-eye view of what occurs behind the scenes in the operation of the national playgrounds.

GEORGE W. FRY,  
*Crater Lake National Park.*



### **The Pennsylvania Bounty System.**

By Richard Gerstell. *Pennsylvania Game Commission Research Bull. 1.* 28 pp. Illus. 1937.

Interesting to the conservationist will be the statement, based on 250 years' experience in the payment of bounties for the killing of predatory wildlife "—it is as yet impossible to prove that any system of general predator control can properly be included in a sound and comprehensive wildlife management program." The bounty system has cost the state of Pennsylvania more than two million dollars, in the period 1915-1935, and has resulted in the control of only one species—the wildcat. No evidence was found to indicate that game conditions had been improved through the setting of a price on "vermin" carcasses.

This study by the Division of Game Research and Distribution deals objectively with facts and figures and apparently is not influenced by the aims of existing legislation or game management policies.

ALBERT G. HALL,  
*U. S. Forest Service.*

**Saatgutprüfung auf biochemischen Wege. [Biochemical Method of Seed Testing.]** By F. E. Eidmann. *Zeitschrift für Forst- und Jagdwesen* 68:422-443. 1936.

What appears to be a very good yet rapid seed-testing method is presented by Dr. Eidmann as a supplement to work done by Hasegawa and others prior to 1932.

So far in seed-testing technique we have for the most part relied on the customary germination test as the most reliable and practical method of testing the utility percent of forest tree seed. Eidmann now proposes a test which actually permits an evaluation of seed utility. This goes beyond the usual result of germination tests—germination capacity—into the vitality of the embryonic seedling.

The method may be described as a chemical method, based on the reaction of the protoplasm to the chemical compound used. The intensity of the reaction of the tissue to the test solution is in direct relation to the degree of enzyme activity within the seed and thus presumably gives an indication of vitality. The test procedure is briefly as follows:

For practical application three test samples of 100 seed each are recommended for the most reliable results. The seed coats are removed, care being taken not to injure the embryos. As this is difficult in the case of some seeds, the author emphasizes the fact that it is not a *conditio sine qua non*. Seed coat removal is recommended primarily to bring about prompt entrance and even distribution of the test solution in the embryo. As the solution used is highly permeable, complete seed coat removal is often unnecessary. In many cases a mechanical puncturing of the outer covering is sufficient to induce adequate penetration.

The seed are allowed to soak in water at room temperature for twenty-four hours, and are then placed in a solution

of sodium biselenite ( $\text{NaH Se O}_3$ ) in distilled water. The optimum concentration of the solution may vary slightly for different species. Too weak a concentration may not bring about any reaction at all, and too strong a concentration may prove toxic in its effect on normal cell functions and thus prevent proper reaction. The author found a 2 per cent solution best with the various species he tested (white pine, white fir, Douglas fir, beech, basswood, locust, and several agricultural seeds such as wheat, barley, beans, and peas). The reviewer, working with yellow poplar (*Liriodendron tulipifera*), also found that a 2 per cent solution gave best results. In general, allowable limits of solution concentration are from one to three per cent.

The seed are left in the solution until no further color change can be noticed. With forest tree seed, twenty-four hours in the solution at room temperature is sufficient to bring about a satisfactory reaction. The embryos are then carefully taken out of the soft, pulpy endosperm and examined macroscopically for visible signs of reaction as indicated by coloration. They are now ready to be classified in one of the following groups:

*Group I:* Entire surface of embryo dyed a rich red.

*Group II:* Intensively dyed only in parts of the surface, but no portion of surface entirely uncolored.

*Group III:* Weakly dyed throughout; or with less than two-thirds of the surface uncolored.

*Group IV:* Not dyed at all or dyed weakly over not more than one-third of the surface area.

The total number of seed in groups I and II indicates the tree utility or plant potentiality per cent. Adding the seed of group III to this sum indicates the germination capacity. Group IV includes non-germinating or dead seed.

This method can be applied simply, cheaply, and within forty-eight hours. Vitality differences between fresh and stored seed can be readily determined. This should prove especially useful in experimental work when attempting to find optimum storage time and conditions or other special treatments needed for many kinds of forest tree seed which undergo definite rest or after-ripening periods prior to germination. For seed of that type (as some species of oak, maple, locust, basswood, yellow poplar, ash, firs, pines, etc.) the method offers additional advantages owing to the fact that seed utility can be determined immediately after collection instead of at the completion of the rest period. This should prove especially helpful to nurserymen and seed dealers in enabling them to complete most of their seed testing work in the fall and winter months.

In concluding the author leaves the thought that the method has not yet been extended to its fullest application. It should not only find broad use in all seed testing laboratories and nurseries, but also may offer many possibilities in the investigative field.

JOHN F. GODFREY,  
*Yale School of Forestry.*



**The Sylvan.** The Forestry Society, Department of Forestry, Pennsylvania State College. 144 pp. *Illus. State College, Penna. 1937. Price \$1.*

Forest school annuals have long been concerned chiefly with undergraduate and alumni activities and have served as memory books for departing seniors. In recent years their scope has been broadened to include real contributions to forest literature. The Penn State *Sylvan* is an example of this new trend. Retaining, and in some cases expanding, its scho-

lastic and alumni sections, it has featured articles of nation-wide and profession-wide interest.


Various phases of forest work are discussed: wildlife management by W. Gard Conklin of the Pennsylvania Game Commission; forest research by I. T. Haig of the U. S. Forest Service; forest insect control by A. J. Jaenicke of the U. S. Forest Service; forestry and grazing by W. B. MacMillan of the Office of Indian Affairs. Private forestry is treated by S. T. Pollock of the Century Division, Wood Preserving Corporation, and Her-

man Work of the West Virginia Pulp and Paper Company.


This issue is dedicated to Prof. John A. Ferguson who, for 25 years head of the Forestry Department of the College, has been a leader and inspiration in forest education.

Well bound, with a stiff, grained cover simulating a wood panel, and brightened with frequent half-tones and line cuts, the *Sylvan* is an achievement in format as well as in content.

ALBERT G. HALL,  
*U. S. Forest Service.*



## CORRESPONDENCE



DEAR NEWINS:

Received your letter of March 16 just before leaving, and observe that the pressure for a professional school of forestry in Florida, which is similar to that in South Carolina, Alabama, Mississippi, Texas, and other states including West Virginia, Ohio, Arizona, etc., is driving you along the road of duplicating and increasing the already large number of institutions already equipped to deal with this demand, and whose output in 1939 is estimated to be 1,000 foresters with probable demand for half or less of that number.

The Society cannot dictate to a sovereign state, and the student citizens of each state clamor for a local institution in which they can receive instruction, of adequate professional character, regardless of the demand for such services after graduation.

The standards of the Society were set up, not to prevent the entrance into the field of new institutions, but to give the profession some assurance that the men who applied for admission as professional foresters have received an adequate training in forestry.

You ask me to specify just what requirements would meet the demands or standards and result in acceptance of your institution as an accredited school.

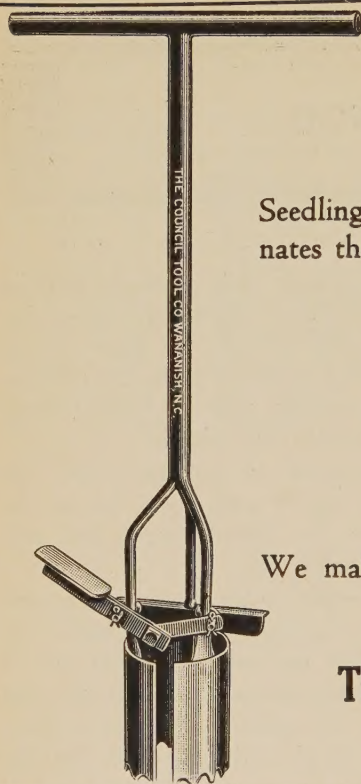
It was to answer such questions that the Society published the report on professional forestry schools, on pages 129 to 150 of which every point is meticulously set forth, together with the exact method used in grading the schools.

The standard of 100 per cent, was arbitrarily set, in each case, not on the figures for the highest school, but considerably below this.

As the result of the grades determined and shown on pages 3 to 6 inclusive, the Council then decided to accredit the 14 schools whose grades totaled 70 per cent and over. Of course, many separate items in these schools fell below 70, but the final weighted average of 70 was accepted.

Objection might be urged against any one of several of these standards, but their final weight in the total grade must be considered, as well as the fact that these weights were determined by the combined judgment of 24 institutions and practically nothing left to the arbitrary decision of the individual making the study. Furthermore, the scales for percentage were uniformly applied to all schools, and are being applied now to 5 of the schools not previously accepted which have asked for a regrading.

H. H. CHAPMAN,  
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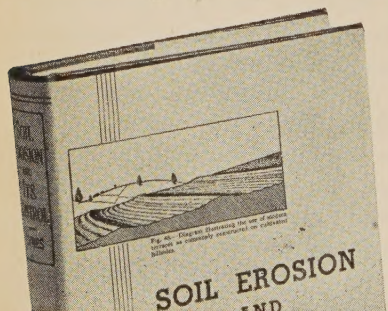
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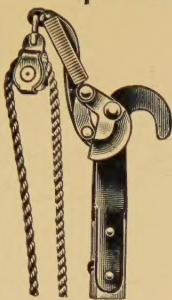
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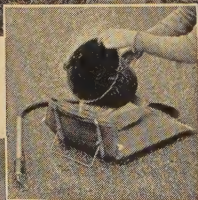
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